Ecodesign preparatory study on mobile phones, smartphones and tablets

Final Task 5 Report

Environment & Economics

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Authors:

Karsten Schischke (Fraunhofer IZM)
Christian Clemm (Fraunhofer IZM)
Anton Berwald (Fraunhofer IZM)
Marina Proske (Fraunhofer IZM)
Gergana Dimitrova (Fraunhofer IZM)
Julia Reinhold (Fraunhofer IZM)
Carolin Prewitz (Fraunhofer IZM)

Contributors:

Antoine Durand (Quality control, Fraunhofer ISI)
Clemens Rohde (Quality control, Fraunhofer ISI)
Simon Hirzel (Quality control, Fraunhofer ISI)
Mihaela Thuring (Quality control, contract management, VITO)

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Contact: Davide Polverini

E-mail: *davide.polverini@ec.europa.eu*

European Commission
B-1049 Brussels

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1. GLOSSARY

Term	Definition
ABS	Acrylonitrile Butadiene Styrene
AMOLED	Active Matrix Organic Light Emitting Diode
BAT	Best Available Technologies
BGA	Ball Grid Array
BNAT	Best Not yet Available Technologies
BOM	Bill-of-Materials
CMOS	Complementary Metal Oxide Semiconductor
CNC	Computerized Numerical Control
CO2	Carbon Dioxide
COG	Chip On Glass
CPU	Central Processing Unit
DECT	Digital Enhanced Cordless Telecommunications
DFN	Dual Flat No-lead
DRAM	Dynamic Random Access Memory
EN	European Norm
EoL	End of Life
EPS	Expanded Polystyrene
eSIM	embedded SIM
EU	European Union
GaAs	Gallium Arsenide
GB	Gigabyte
GF	Glass Fibre
GPU	Graphics Processing Unit
HD	High Definition
Hz	Hertz
IC	Integrated Circuit
ICT	Information and Communications Technology
IP	Internet Protocol
IPS	In-Plane Switching
ISO	International Organization for Standardization
ITO	Indium-Tin-Oxide
JRC	Joint Research Centre
kWh	Kilowatt Hour
LCA	Life Cycle Assessment
LCD	Liquid Crystal Display
LCO	Lithium-Cobalt-Oxid
LDPE	Low Density Polyethylen
LED	Light Emitting Diode
LGA	Land Grid Array
LIB	Lithium-Ion Battery
LLCC	Least Life Cycle Cost
mAh	Milliampere Hour
MCU	Microcontroller Unit
MEErP	Methodology for the Ecodesign of Energy-related Products
MLCC	Multi-Layer Ceramic Capacitors
NAND	Not And

Term	Definition
NiMH	Nickel-Metal Hydride
OEM	Original Equipment Manufacturer
OLED	Organic Light Emitting Diode
PA	Power Amplifiers
PA	Polyamide
PC	Polycarbonate
PCB	Printed Circuit Board
PCR	Post Consumer Recycled
PCT	Projected Capacitive Touch
PIR	Post Industrial Recycled
PMMA	Poly(methyl methacrylate)
PoP	Package-on-Package
PSU	Power-Supply Unit
PVC	Polyvinyl Chloride
QFN	Quad Flat No-Lead
rABS	recycled Acrylonitrile Butadiene Styrene
RAM	Random-Access Memory
RF	Radio Frequency
RJ	Registered Jack
SD	Secure Digital
SDHC	Secure Digital High Capacity
SDRAM	Synchronous Dynamic Random Access Memory
SDXC	Secure Digital Extended Capacity
SIM	Subscriber Identity Module
SMD	Surface Mounted Devices
SME	Small and Medium Enterprise
SoC	System-on-Chip
SOC	State Of Charge
SOT	Small Outline Transistor
SSD	Solid State Drive
TB	Terrabyte
TEP	Triethyl Phosphate
TPU	Thermoplastic Polyurethane
TWh	Terrawatt Hour
US	United States
USB	Universal Serial Bus
V	Volt
W	Watt
WEEE	Waste Electrical and Electronic Equipment

2. INTRODUCTION

Preparatory studies aim to assess and specify generic or specific ecodesign measures for improving the environmental performance of a defined product group, sometimes in combination with energy label criteria. The ecodesign preparatory studies therefore provide the scientific foundation for defining these generic and/or specific ecodesign requirements as well as energy labelling criteria. The overall objective is to clearly define the product scope, analyse the current environmental impacts of these products and related systems (extended product scope) and assess the existing improvement potential of any measures. The central element of the MEErP (Kemna 2011; Mudgal et al. 2013), being the underlying assessment methodology, is to prioritise today's possible improvement options from a Least Life Cycle Cost (LLCC) perspective. Identification of the improvement options are based on possible design innovations, Best Available Technologies (BAT) for the short term and Best Not yet Available Technologies (BNAT) for long term, that can help in mitigating the impacts of these products. Policy options are assessed through a scenario analysis and the different outcomes have to be evaluated from the perspective of the EU targets, taking into account potential impacts on the competitiveness of enterprises in the EU and on the consumers.

Objective: In Task 5, building on appropriate information from each of the previous tasks, especially Tasks 2 to 4, base cases for each of the product categories are defined. Such base-cases are "conscious abstractions from reality" (Kemna et al. 2005), especially in the sense that average "virtual" products/base-cases will be defined based on market share of the different underlying technologies. Each base-case is comprehensively evaluated with regard to environmental impact, life-cycle costs for consumers and EU totals. These base-cases serve as a point of reference to analyse technical design options in Task 6.

3. SUBTASK 5.1 – PRODUCT SPECIFIC INPUTS

This subtask provides all relevant quantitative base case information from previous tasks and prepares for the modelling exercise in the rest of Task 5. The data input derives from the previous Tasks 3 and 4.

3.1. Modelling overview

The vast majority of products in this product group of mobile phones, smartphones and tablets are smartphones (approx. 135 million units sold in EU 27 per year), market size of the other product segments is significantly smaller (feature phones, cordless landline phones, and tablet computers each in the range of 15 million units). Although each of these sub-segments is characterised by a broader range of technical features an appropriate distinction of base-cases is as follows, based on the technical analysis provided in Task 4:

- BC1: Smartphone, display 5", low-end price segment
- BC2: Smartphone, display 6", mid-range
- BC3: Smartphone, display 6,5", high-end
- BC4: Feature phone
- BC5: DECT cordless landline phone, with charging cradle / base station
- BC6: Tablet (no attached keyboard)

Further below a documentation of the actual entries in the EcoReport template per Base Case is provided (chapters 3.1.4 - 3.7). As this way of presenting the product specific inputs does not allow directly to compare individual entries across Base Cases, be reminded that main entries are presented in summary tables already elsewhere in other Task reports. This is where you will find these overviews, which will not be copied here:

- Bill of material general structure: Task 4, 4.1, Table 31
- Type and weight of accessories: Task 4, 4.1
- Packaging materials and weights: Task 4, 4.3, Table 32
- Distribution, i.e. volume of packages: Task 4, 4.4, Table 34

- Energy consumption: this Task, 3.1.2, Table 5 and Table 7
- End of life: this Task, 3.1.4, Table 36
- Product life: Task 4, 4.6, Table 35
- Stock and sales: Task 2, now broken down per Base Case
- Repair costs: this Task, 3.1.3, Table 8

3.1.1. Bill of Materials derived from technical specifications

Specific aspects of relevance for the modelling of the base cases is listed in the tables below. The modelled base cases do not represent distinct "real world" products, but a technology mix typical for the represented market segment. This is evident in the case of the mid-range smartphone (Base Case 2), which is modelled with 50% LCD and 50% OLED display (Table 1).

Table 1 : Base Cases 1 – 3 – Technical specifications for BoM modelling

Parameter	Value		
	BC1 – low-end / entry	BC2 – mid-range	BC3 – high-end
Weight	150 g	180 g	195 g
Display size	5" (16:9, 69cm²)	6" (18:9, 93cm²)	6,5" (20:9, 102cm²)
Display type	LCD	50% LCD, 50% OLED	OLED
Display design	traditional	water drop	hole punch
Main housing material	plastics	aluminum, plastics	aluminum
backcover	plastics	aluminum, plastics	glass
CPU (SoC), examples	Qualcomm Snapdragon 801, Quad-core 2,26 GHz Mediatek MT6761, Quad-Core 2 GHz	Qualcomm Snapdragon 845, Octa-Core 2,8 GHz Qualcomm Snapdragon 855	Exynos 990, Octa-Core 2,73 GHz Apple A13 Bionic
GPU, examples, SoC integrated		Adreno 630	Mali G77 MP11
RAM	2 GB	4 GB	8 GB
Flash memory	32 GB	64 GB	128 GB
Mainboard	6-layers, 75cm² (incl. cut-offs)	8-layers, 35cm² (incl. cut-offs)	10-layers, 43cm² (incl. cut-offs, stacked)
Other rigid boards	(mainboard covers all connectors / interfaces)	6-layers, 8cm²	8-layers, 6cm²
Flex PCBs	Very few, distances bridged by mainboard	Double-sided, 50 cm² (mainboard to sub-board flex, miscellaneous other module flexes)	Double-sided, 50 cm² (mainboard to sub-board flex, miscellaneous other module flexes)
Mobile network	up to 4G/LTE	up to 4G/LTE	up to 5G
Battery capacity and weight	2400 mAh	3330 mAh	4500 mAh
Battery design	Integrated, with adhesive	Integrated, with adhesive	Integrated, with pull strips
Cameras	1 + 1	1 + 1	4 + 1
IP class	none	none	IP 67 or 68
Wireless charging	no	no	yes
Price	200 €	500 €	1000 €

In past years there is a trend by some OEMs to market devices with high-end specification rather in the mid-range price segment. The definition of the low-end, mid-range, and high-end segment is not straight forward and shifts over time.

For Base Cases 4 and 5 all relevant data for the BoM modelling is provided in Task 4. Further details for the technical modelling of Base Case 6 are provided in Table 2. The tablet Base Case is meant to represent the whole tablet market, which inevitably requires some simplifications.

Table 2 : Base Case 6 – Technical specifications for BoM modelling

Parameter	Value
	BC6 - tablet
Weight	600 g
Display size	11" (337cm²)
Display type	LCD
Display design	traditional
Main housing material	plastics, aluminum
backcover	plastics, aluminum
CPU (SoC)	Typical: Quad-core, 1,8 GHz
GPU	SoC integrated
RAM	4 GB
Flash memory	64 GB
Mainboard	6-layers, 100cm² (incl. cut-offs)
Other rigid boards	6-layers, 8cm²
Flex PCBs	Double-sided, 60 cm² (mainboard to sub-board flex, miscellaneous other module flexes)
Mobile network	none
Battery capacity	6000 mAh
Battery design	Integrated, with adhesive or screwed frame
Cameras	1 + 1
IP class	none
Wireless charging	no
Price	330 €

3.1.2. Use phase modelling

The active battery charge energy consumption depends on the capacity of the battery and the charging efficiency. Battery capacity for the different base cases is stated in Table 3. The battery capacity in Wh is calculated as the product of the battery capacity in mAh and the typical battery voltage of 3,8 volts for smartphones, tablets, and feature phones, and 1,2V for the DECT AAA batteries (two or three batteries in series resulting in 2.4 or 3.6V). The energy consumption per full charging process was calculated from the battery capacity in Wh using an overall charging efficiency of 60 %.

Table 3 : Base Cases - Battery capacities

Base Case	Battery capacity [mAh]	Battery capacity [Wh]	Energy consumption per full charge
BC1 Smartphone – low-end	2400 mAh	9,2 Wh	15,3 Wh
BC2 Smartphone – mid-range	3330 mAh	12,7 Wh	21,2 Wh
BC3 Smartphone – high-end	4500 mAh	17,1 Wh	28,5 Wh
BC4 Feature phone	1200 mAh	4,6 Wh	7,7 Wh
BC5 DECT phone	2 x AAA NiMH (800 mAh each)	1,9 Wh	3,2 Wh
BC6 Tablet	6000 mAh	22,8 Wh	38 Wh

The study makes the following assumptions regarding the daily user behaviour: The battery of base cases 1 through 5 is fully charged (from approx. 0 to 100 % SOC) daily. The battery of the tablet is only fully charged once in two days. The charging process is estimated to take 2,5 hours for each base case except for tablets, which is estimated to take 5 hours. The device are assumed to remain connected to the charging adapter after the charging process is completed for another 9,5 hours in trickle charge mode or maintenance mode to re-start charging when the battery has self-discharged over a period of time. The charging adapter remains plugged into mains at all times, resulting in 12 hours adapter no-load power consumption Table 4.

Table 4 : Base Cases 1 – 4 and 6 – Daily times in the various modes

Base Case	Charge cycles / day	Daily time spent in		
		Active battery charge	Trickle charge	Power adapter no-load
BC1 Smartphone – low-end	1	2,5 h	9,5 h	12 h
BC2 Smartphone – mid-range	1	2,5 h	9,5 h	12 h
BC3 Smartphone – high-end	1	2,5 h	9,5 h	12 h
BC4 Feature phone	1	2,5 h	9,5 h	12 h
BC6 Tablet	0,5	2,5 h	9,5 h	12 h

The trickle charge mode and adapter no-load are assumed to be relatively steady over time. The active battery charge energy consumption in contrast varies over time during the process. This is due to different charge rates being applied during different phases of the charging process.

Table 5 : Base Cases 1 – 4 and 6 – Power consumption in the various modes

Mode of operation	Temporal share per day	Base Cases	Power consumption	Energy consumption
Active battery charge	2,5 hours	1	6,12 W	15,3 Wh
		2	8,48 W	21,2 Wh
		3	11,4 W	28,5 Wh
		4	3,08 W	7,7 Wh
		6	7,6 W	19 Wh
Trickle charge	9,5 hours	1-4, 6	0,5 W	4,75 Wh
Adapter no-load	12 hours	1-4, 6	0,02 W	0,24 Wh

Base Case 5 is different in so far as the phone typically sits in the base station / charging cradle most of the time and is removed only for calls. Given a daily talk time of 10 minutes per day, the batteries are 1% drained (average talk time with a fully charged battery: 17,7 hours, see Task 4 analysis). As in average a full battery charge takes 7,6 hours (see Task 4) the battery is charged for 4,5 min per day. The remaining time the cordless phone and the base station are in standby (Table 6).

Table 6 : Base Case 5– Daily times in the various modes

Base Case	Call duration per day	Daily time spent in		
		Active	Active battery charge	Standby
BC5 DECT phone	10 min	0,16 h	0,075 h	23,765 h

The power consumption while the battery is recharged is the sum of the charging process with its losses and the standby of the base station and the radio connection. As the charging requires approximately 0,4 W (full charge 3,2 W at 7,6 hours charging time), the power consumption in this mode is roughly 1 W. Power in active mode, i.e. when the handset is removed from the base station and a radio connection is established between handset and base station depends on several factors and mainly on the distance between both. Power consumption will typically be well below 2 W[1], with 1,5 W as an estimate. Energy consumption for Base Case 5 is as listed in the table below.

Table 7 : Base Cases 5 – Power consumption in the various modes

Mode of operation	Temporal share per day	Power consumption	Energy consumption
Active	0,16 hours	1,5 W	0,24 Wh
Active battery charge	0,075 hours	1 W	0,075 Wh
Standby	23,925 hours	0,6 W	14,3 Wh

3.1.3. Repair scenario modelling

The standard repair scenario for the Base Case modelling requires some simplifications with a focus on most relevant repairs. To calculate repair costs per Base Case data on repair costs per most relevant defect, share of devices being subject to such a defect and the share of actual repairs undertaken – in contrast to continued use of a defective device and to end of use life – has to be taken into account. In that sense, a defect has to be understood as a decision point, where the user follows one of the following options:

- Getting a repair done
- Continue device use, despite the functional limitations caused by the defect
- Discontinue the use of the device and disposing it off after potentially a phase of hibernation

The Base Cases are calculated with the data derived from prior tasks and plotted onto the six Base Cases as listed in Table 8.

This scenario differentiates display and battery repairs, and repair of all other components under a joint heading. These "other" defects and repair cases relate to the backcover, but also connectors, camera modules, speakers, sub-boards, buttons and similar, all of which are less frequent failure causes than the display / screen and – over lifetime – the battery. Battery replacements will become more relevant with progressing age of the device, whereas display defects are likely more evenly spread over the product lifetime with decreasing tendency to get these defects fixed. Repair costs include labour costs except for the cordless phone and feature phone battery replacement where the user typically can exchange the battery with limited effort.

[1] Which corresponds to the rating of typical chargers for cordless phones

Table 8 : Base Cases Repair Cost Scenario

Base Case	New device costs	Repair costs			Defect devices over lifetime									
		Display	Battery	Other	Display / cover glass				Battery			Other		
						thereof				thereof			thereof	
						repaired	continued use	disposal / hibernation		repaired	disposal / hibernation		repaired	disposal / hibernation
1	200 €	120 €	55 €	55 €	16,7%	4,2%	4,2%	8,4%	12,5%	4,2%	8,4%	12,5%	4,2%	8,4%
2	500 €	200 €	60 €	60 €	20%	5%	5%	10%	15%	5%	10%	15%	5%	10%
3	1000 €	330 €	75 €	75 €	23,3%	5,8%	5,8%	11,6%	17,5%	5,8%	11,6%	17,5%	5,8%	11,6%
4	80 €	50 €	30 €	50 €	7,5%	2,5%	-	5%	15%	5%	10%	15%	5%	10%
5	50 €	-	7 €	-	-	-	-	-	65%	50%	15%	-	-	-
6	330 €	150 €	90 €	90 €	10%	5%	-	5%	15%	5%	10%	15%	5%	10%

Notes:

(1) Device and repair costs are derived from the analysis provided in Task 2. "other" repair costs are meant to cover other repair cases, including back cover defects (mainly BC 1), water ingress (rather the other base cases), faulty connectors and similar. Although this spans a broad (price) range of components battery replacement costs are used as proxy value except for BC 4 (feature phones), where the battery is typically much better accessible than other parts and display replacement is considered a more appropriate proxy instead.

(2) The data provided in Task 3 does not provide an unambiguous picture of how many devices actually encounter a defect and which share of the devices is actually repaired. The data on defect devices and repair practice is a plausible scenario based on the available data points.

(3) In this scenario approximately 30% of the smartphones are taken out of service due to defects, which is less than recent Eurobarometer (European Commission 2020) data suggests (broken digital device in 37% of the cases main reason to buy a new one), roughly in the 26% range identified by a survey in 2016 (Greenpeace 2016), but more in case of the total display defects of roughly 15% as suggested by a survey in Germany (clickrepair 2019), all three references cited in Task 3 in more detail

(4) It is assumed that in the course of a five years lifetime of cordless phones (BC 5) in 50% of the cases the batteries have to be exchanged and that this is not a crucial point in time where users decide about upgrading to another cordless phone.

3.1.4. End-of-life scenario

Based on the analysis in Task 4 a plausible EoL scenario for the base cases are as summarised in Table 9. The reuse of devices through second hand sales, through the re-commerce business, and family and friends cascade use is already reflected in the use lifetime analysis. Reuse stated in the table below refers to devices provided to collection schemes and similar, which are sorted out for potential reuse elsewhere, typically outside the EU 27.

The large share of hibernating devices constitutes a major uncertainty of the overall analysis as sooner or later the owner will dispose such a devices, and it is highly speculative, if this will be done then through proper recycling routes or with the household waste – or otherwise. Given the (few) data points on household waste disposal indicating a significantly higher share of devices disposed of in the household waste than through WEEE recycling suggests that this might be also the case for the hibernating stock in the end.

Table 9 : Base Cases – End-of-life scenarios

		Reuse	Recycling [2]	Household waste	Hibernation
1	Smartphone, 5”, low-end	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
2	Smartphone, 6”, mid-range	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
3	Smartphone, 6,5”, high-end	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
4	Feature phone	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-
5	DECT cordless landline phone, with charging cradle / base station	0%	22%	20%	58%
	total after hibernation	*0%*	*50%*	*50%*	-
6	Tablet	10%	5%	20%	65%
	total after hibernation	*10%*	*20%*	*70%*	-

3.2. Base Case 1: Smartphone, display 5”, low-end price segment

Input data for the EcoReport assessment for this and the following Base Cases comprises bill of materials data in the sense of a parts and materials weight composition, manufacturing data where actually only the metal sheet scrap rate can be adapted, product volume, energy consumption, end-of-life scenario, and lifetime and economic figures.

Data in the EcoReport column “Recyclable” has on purpose an effect on plastics only as explained in the MEErP methodology (Kemna 2011). “Yes” should be stated for all plastic parts, which per design are likely to be recycled. These are for the Base Cases larger housing parts only. This column has no effect on how other materials are modelled and is thus left blank for all other materials.

[2] i.e. share of devices entering state-of-the-art WEEE pre-processing and recycling

3.2.1. Bill of Materials

The Bill of Materials is split in handset (the actual smartphone, Table 10 and Table 11), accessories sold in the same package, and packaging material as such (both in Table 12).

Table 10 : Base Case 1 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 1 - smartphone, 5", entry		Date	Author	
	Products			03.11.2020 Fraunhofer IZM	
Pos nr	**MATERIALS Extraction & Production Description of component**	**Weight in g**	**Category Click &select**	**Material or Process select Category first !**	**Recyclable?**
1	**Total handset (150g)**				
2	Battery (2420mAh)	37,79	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	*1,50*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display 5” (16:9, 69cm²), LCD	*69,00*	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,40	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	1,50	2-TecPlastics	14 -PMMA	
7	OLED	*0,00*	8-Extra	113-AMOLED panel per cm²	
8	Display PCB	*3,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Cover glass	18,00	8-Extra	114-Glass per g	
10	Backside glass	0,00	8-Extra	114-Glass per g	
11	Midframe (Mg)	0,00	4-Non-ferro	34 -MgZn5 cast	
12	Cover, housing	30,00	2-TecPlastics	13 -PC	No
13	Backcover, housing	0,00	4-Non-ferro	27 -Al sheet/extrusion	
14	Machining losses aluminum	0,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,00	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	10,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,05	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	4,00	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,50	8-Extra	115-Silicone	
20	**Mainboard**				
21	PCB substrate, 6-layers, 75cm²	*75,00*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
22	CPU SoC (1,5cm² package size, 0,5cm² die size)	*0,50*	8-Extra	117-IC, SoC per cm² die area	
23	RAM, 2GB (1,5cm² package size, 0,5cm² die size)	*0,50*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, 32GB (1,5cm² package size, 2cm² total die size)	*2,00*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 3 mg)	3,00	5-Coating	42 -Au/Pt/Pd	
26	other ICs (1,5cm² total die size)	*1,50*	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 0,4 mg)	0,40	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,04	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,60	6-Electronics	49 -SMD/ LED's avg.	
30	coils	1,00	3-Ferro	25 -Ferrite	
31	various connectors, incl. SIM card slot, Board-to-board connectors, USB	1,20	6-Electronics	46 -slots / ext. ports	
32	additional gold connectors in mg	3,00	5-Coating	42 -Au/Pt/Pd	
33	steel sheets (EMI shields)	4,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,40	6-Electronics	53 -Solder SnAg4Cu0.5	
35	eSIM	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
36	5G components (modem and antenna ICs)	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
37	heat pipe	0,00	4-Non-ferro	31 -Cu tube/sheet	
38					
39					
40					

Table 11 : Base Case 1 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-boards (components included above)**				
42	PCB	*0,00*	8-Extra		
43	**Flex boards (5cm²)**	*5,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cı	
44	solder on flex	0,10	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,01	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	1,00	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,80	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BlkPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	1,20	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,02	8-Extra	115-Silicone	
55	**Vibration alert**				
56	Magnet	0,20	8-Extra	116-NdFeB magnet	
57	other mechancial parts, incl. Tungsten	1,20	4-Non-ferro	31 -Cu tube/sheet	
58	**Front camera (1x)**				
59	Sensor chip, 0,2cm³	0,20	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (0,5mg)	0,50	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	0,30	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	0,60	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,20	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,01	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,10	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,10	8-Extra	116-NdFeB magnet	
67	cover	0,20	2-TecPlastics	14 -PMMA	No
68	glass	0,10	8-Extra	114-Glass per g	
69	**flash light**	0,10	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,2cm³	*0,20*	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,5mg)	0,50	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,30	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,10	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,005	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,05	4-Non-ferro	29 -Cu winding wire	
78	cover	0,10	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	0,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	0,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws**	0,20	4-Non-ferro	32 -CuZn38 cast	
83					
84					
85					
86					
87					

Some entries are scaled by size (displays, printed circuit boards, integrated circuits), not weight. These all belong to the category "8-Extra". These values are in *italics* in the EcoReport BoM entries. Furthermore some other new datasets modelled per weight have been introduced under "8-Extra". For all new datasets under "8-Extra" see 3.8. As this would lead to wrongly calculated overall weights, and to correctly model weights for total resource consumption and recycling, the weight of these "8-Extra" parts is listed separately as weight conversion factors for the other material categories (at the top of Table 12). Values stated for "8-Extra" parts are not considered in the later total weights figures.

Table 12 : Base Case 1 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	30,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	37,79	6-Electronics		
91	Display (covered under "8-Extra")	15,00	6-Electronics		
92	Glass	18,00	7-Misc.		
93	Silicone	0,52	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (40g)**				
98	Back housing (PC+ABS)	6,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	6,00	1-BlkPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots / ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (13cm²)	*13,00*	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	5,33	6-Electronics	45 -big caps & coils	
107	Capacitors	3,00	6-Electronics	45 -big caps & coils	
108	coils	0,30	3-Ferro	25 -Ferrite	
109	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
111	solder	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	10,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	No
116	connectors	10,00	6-Electronics	46 -slots / ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	No
122	speaker magnets	0,00	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (200 g)**				
129	Cardboard	150,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BlkPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132					
133					
134					

3.2.2. Distribution

For the distribution phase the Ecoreport tool requires the volume of the final packaged product to be entered as an input. Based on this volume, the impact of transport of the product to the site of installation is calculated. In the distribution phase the final assembly per m^3 packaged final product is also taken into account in the EcoReport tool.

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption is considered for calculations as it is the most likely scenario.

Table 13 : Base Case 1 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)	
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	60	1
209	Is it an installed appliance (e.g. boiler)?		NO	61	0
				63	1
210	Volume of packaged final product in m^3	in m3	0,00066	64	0
				65	1

3.2.3. Energy consumption

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 5, p. 17. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 7,25 g (not depicted in the screenshot below).

Table 14 : Base Case 1 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals	
226	ErP Product (service) Life in years	2,50	years		
	Electricity				
227	Active battery charge: Consumption per hour, cycle, setting, etc.	0,00612	kWh	5,5845	
228	Active battery charge: No. of hours, cycles, settings, etc. / year	912,50	hrs.		
229	Trickle charge: Consumption per hour	0,00050	kWh	1,73375	
230	Trickle charge: No. of hours / year	3467,50	hrs.		
231	Adapter no-load: Consumption per hour	0,00002	kWh	0,0876	
232	Adapter no-load: No. of hours / year	4380,00	hrs.		
	TOTAL over ErP Product Life	0,0185	MWh (=000 kWh)	66	

3.2.4. End-of-Life

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Reuse as stated before, means actually reuse outside of EU27. Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 2,5 years.

Table 15 : Base Case 1 – End of life

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	2,5	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	54,000	54,000	0,0%	0,0%
255	product & aux. mass over service life, in g/unit	732	732	0,0%	0,0%
256	total mass sold, in t (1000 kg)	39,51900659	39,51900659	0,0%	0,0%

Pos nr	Per fraction (post-consumer)	1 Bulk Plastics	2 TecPlastics	3 Ferro	4 Non-ferro	5 Coating	6 Electronics	7a Misc., excluding refrigant & Hg	7b refrigerant	7c Hg (mercury), in mg/unit	8 Extra	9 Auxiliaries	TOTAL (CARG avg.)
257	current fraction, in % of total mass (or mg/unit Hg)	2,2%	8,0%	2,4%	3,4%	1,0%	16,0%	28,7%	0,0%	0,0	38,2%	0,0%	100,0%
258	fraction x years ago, in % of total mass	2,2%	8,0%	2,4%	3,4%	1,0%	16,0%	28,7%	0,0%	0,0	38,2%	0,0%	100,0%
259	CAGR per fraction r, in %	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	
	current product mass in g	*16*	*58*	*18*	*25*	*8*	*117*	*210*	*0*	*0*	*280*	*0*	*732*
260	stock-effect, total mass in g/unit	0	0	0	0	0	0	0	0	0,0	0	0	*0*
261	EoL available, total mass ('arisings') in g/unit	16	58	18	25	8	117	210	0	0,0	280	0	*732*
262	EoL available, subtotals in g	74		50			117	210	0	0,0	280	0	*732*
													AVG
263	EoL mass fraction to re-use, in %						10%					0%	*10,0%*
264	EoL mass fraction to (materials) recycling, in %	0%	0%	0%	0%	0%	20%	80%	0%	0%	20%	0%	*33,8%*
265	EoL mass fraction to (heat) recovery, in %	20%	20%	20%	20%	20%	0%	20%	0%	0%	0%	0%	*9,1%*
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	*0,0%*
267	EoL mass fraction to landfill/missing/fugitive, in %	70%	70%	70%	70%	70%	70%	0%	0%	0%	70%	0%	*49,9%*
268	TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*0%*	*0%*	*100%*	*0%*	*102,9%*
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	*avg*
		0%	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	

3.2.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19.

The cost data does not include costs for mobile subscription, payed apps or similar. Although these costs are relevant for the business models of various parties and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 16 : Base Case 1 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**2,50**	years
B	Annual sales	54,00	mln. Units/year
C	EU Stock	135,00	mln. Units
D	Product price	200,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	9,66	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	2,50	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.3. Base Case 2: Smartphone, display 6", mid-range

3.3.1. Bill of Materials

The Bill of Materials is split in handset (the actual smartphone, Table 17 and Table 18), accessories sold in the same package, and packaging material as such (both in Table 19).

Table 17 : Base Case 2 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 2 - smartphone, 6", mid-range Products		Date 27.10.2020	Author Fraunhofer IZM	
Pos nr	**MATERIALS Extraction & Production Description of component**	**Weight in g**	**Category Click &select**	**Material or Process select Category first !**	**Recyclable?**
1	**Total handset (180g)**				
2	Battery (3330mAh)	52,00	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	*1,50*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display 6" (18:9, 93cm²), 50% LCD	*46,50*	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,50	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	2,00	2-TecPlastics	14 -PMMA	
7	Display 6" (18:9, 93cm²), 50% OLED	*46,50*	8-Extra	113-AMOLED panel per cm²	
8	Display PCB	*3,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Cover glass	20,00	8-Extra	114-Glass per g	
10	Backside glass	0,00	8-Extra	114-Glass per g	
11	Midframe (Mg)	15,00	4-Non-ferro	34 -MgZn5 cast	
12	Cover, housing	15,00	2-TecPlastics	13 -PC	No
13	Backcover, housing	20,00	4-Non-ferro	27 -Al sheet/extrusion	
14	Machining losses aluminum	80,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,20	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	10,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,05	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	3,00	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,50	8-Extra	115-Silicone	
20	**Mainboard**				
21	PCB substrate, 8-layers, 35cm²	*35,00*	8-Extra	104-FR4 PCB Ni/Au-Finish 8-layers per cm²	
22	CPU SoC (1,5cm² package size, 1cm² die size)	*1,00*	8-Extra	117-IC, SoC per cm² die area	
23	RAM, 4GB (1,5cm² package size, 1cm² die size)	*1,00*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, 64GB (1,5cm² package size, 3cm² total die size)	*3,00*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 5 mg)	5,00	5-Coating	42 -Au/Pt/Pd	
26	other ICs (3cm² total die size)	*3,00*	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 0,9 mg)	0,90	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,05	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,70	6-Electronics	49 -SMD/ LED's avg.	
30	coils	1,20	3-Ferro	25 -Ferrite	
31	various connectors, incl. SIM card slot, Board-to-board connectors, USB	1,50	6-Electronics	46 -slots / ext. ports	
32	additional gold connectors in mg	5,00	5-Coating	42 -Au/Pt/Pd	
33	steel sheets (EMI shields)	4,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,40	6-Electronics	53 -Solder SnAg4Cu0.5	
35	eSIM	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
36	5G components (modem and antenna ICs)	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
37	heat pipe	0,00	4-Non-ferro	31 -Cu tube/sheet	
38					

Bill of materials data includes aluminum machining losses to account for the high share of material milled out of extruded or die cast aluminium parts, in line with the analysis provided in Task 4.

Table 18 : Base Case 2 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-boards (components included above)**				
42	PCB substrate, 6-layers, 8cm²	*8,00*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
43	**Flex boards (50cm²)**	*50,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cı	
44	solder on flex	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,05	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	1,00	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,80	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BlkPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	1,20	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,02	8-Extra	115-Silicone	
55	**Vibration alert**				
56	Magnet	0,20	8-Extra	116-NdFeB magnet	
57	other mechancial parts, incl. Tungsten	1,20	4-Non-ferro	31 -Cu tube/sheet	
58	**Front camera (1x)**				
59	Sensor chip, 0,4cm³	0,40	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (1mg)	1,00	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	0,30	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	0,60	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,20	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,01	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,10	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,10	8-Extra	116-NdFeB magnet	
67	cover	0,20	2-TecPlastics	14 -PMMA	No
68	glass	0,10	8-Extra	114-Glass per g	
69	**flash light**	0,10	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,3cm³	*0,30*	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,75mg)	0,75	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,30	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,10	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,005	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,05	4-Non-ferro	29 -Cu winding wire	
78	cover	0,10	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	0,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	0,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws**	0,50	4-Non-ferro	32 -CuZn38 cast	
83					

The weight of “8-Extra” parts is listed separately as weight conversion factors for the other material categories (at the top of Table 19).

Table 19 : Base Case 2 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	20,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	52,00	6-Electronics		
91	Display (covered under "8-Extra")	15,00	6-Electronics		
92	Glass	20,00	7-Misc.		
93	Silicone	0,52	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (40g)**				
98	Back housing (PC+ABS)	6,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	6,00	1-BlkPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots / ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (13cm²)	*13,00*	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	5,33	6-Electronics	45 -big caps & coils	
107	Capacitors	3,00	6-Electronics	45 -big caps & coils	
108	coils	0,30	3-Ferro	25 -Ferrite	
109	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
111	solder	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	10,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	
116	connectors	10,00	6-Electronics	46 -slots / ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	
122	speaker magnets	0,80	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (250 g)**				
129	Cardboard	200,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BlkPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132					

3.3.2. Distribution

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption is a very likely scenario.

Table 20 : Base Case 2 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)	
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	60	1
209	Is it an installed appliance (e.g. boiler)?		NO	61	0
				63	1
210	Volume of packaged final product in m^3	in m3	0,00068	64	0
				65	1

3.3.3. *Energy consumption*

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 5, p. 17. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 8,99 g (not depicted in the screenshot below).

Table 21 : Base Case 2 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals
226	ErP Product (service) Life in years	3,00	years	
	Electricity			
227	Active battery charge: Consumption per hour, cycle, setting, etc.	0,00848	kWh	7,738
228	Active battery charge: No. of hours, cycles, settings, etc. / year	912,50	hrs.	
229	Trickle charge: Consumption per hour	0,00050	kWh	1,73375
230	Trickle charge: No. of hours / year	3467,50	hrs.	
231	Adapter no-load: Consumption per hour	0,00002	kWh	0,0876
232	Adapter no-load: No. of hours / year	4380,00	hrs.	
	TOTAL over ErP Product Life	0,0287	MWh (=000 kWh)	66

3.3.4. *End-of-Life*

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Reuse as stated before, means actually reuse outside of EU27. Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 3 years.

As part of the material entries in the BoM are aluminum machining losses, which in fact are post-industrial waste with an assumed high recycling rate and not as post-consumer waste, the recycling rate for non-ferro materials is adapted here.

Table 22 : Base Case 2 – End of life

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	3	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	45,000	45,000	0,0%	0,0%
255	product & aux. mass over service life, in g/unit	907	907	0,0%	0,0%
256	total mass sold, in t (1000 kg)	40,8371886	40,8371886	0,0%	0,0%

Pos nr	Description	1	2	3	4	5	6	7a	7b	7c	8	9	
	Per fraction (post-consumer)	Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigerant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	TOTAL (CARG avg.)
257	current fraction, in % of total mass (or mg/unit Hg)	1,8%	4,8%	2,0%	15,5%	1,4%	13,5%	28,9%	0,0%	0,0	32,1%	0,0%	100,0%
258	fraction x years ago, in % of total mass	1,8%	4,8%	2,0%	15,5%	1,4%	13,5%	28,9%	0,0%	0,0	32,1%	0,0%	100,0%
259	CAGR per fraction r, in %	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	
	current product mass in g	*16*	*44*	*18*	*140*	*13*	*122*	*263*	*0*	*0*	*291*	*0*	*907*
260	stock-effect, total mass in g/unit	0	0	0	0	0	0	0	0	0,0	0	0	*0*
261	EoL available, total mass ('arisings') in g/unit	16	44	18	140	13	122	263	0	0,0	291	0	*907*
262	EoL available, subtotals in g		60		171		122	263	0	0,0	291	0	*907*
													AVG
263	EoL mass fraction to re-use, in %						10%					0%	*10,0%*
264	EoL mass fraction to (materials) recycling, in %	0%	0%	0%	57%	0%	20%	80%	0%	0%	20%	0%	*43,1%*
265	EoL mass fraction to (heat) recovery, in %	20%	20%	20%	0%	20%	0%	20%	0%	0%	0%	0%	*7,1%*
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	*0,0%*
267	EoL mass fraction to landfill/missing/fugitive, in %	70%	70%	70%	33%	70%	70%	0%	0%	0%	70%	0%	*42,8%*
268	TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*0%*	*0%*	*100%*	*0%*	*102,9%*
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	*avg*
		0%	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	*0%*	

3.3.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19. Costs include spare parts and labour costs.

The cost data does not include costs for mobile subscription, payed apps or similar. Although these costs are relevant for the business models of various parties and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 23 : Base Case 2 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**3,00**	years
B	Annual sales	45,00	mln. Units/year
C	EU Stock	135,00	mln. Units
D	Product price	500,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	16,00	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	3,00	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.4. Base Case 3: Smartphone, display 6,5”, high-end

3.4.1. Bill of Materials

The Bill of Materials is split in handset (the actual smartphone, Table 24 and Table 25), accessories sold in the same package, and packaging material as such (both in Table 26).

Table 24 : Base Case 3 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 3 - smartphone, 6,5", high-end	Date	Author
	Products	27.10.2020	Fraunhofer IZM

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	**Total handset (195g)**				
2	Battery (4500mAh)	70,00	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	*1,50*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display, LCD	*0,00*	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,00	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	0,00	2-TecPlastics	14 -PMMA	
7	Display 6,5" (20:9, 102cm²), OLED	*102,00*	8-Extra	113-AMOLED panel per cm²	
8	Display PCB	*3,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Cover glass	22,00	8-Extra	114-Glass per g	
10	Backside glass	10,00	8-Extra	114-Glass per g	
11	Midframe (Mg)	0,00	4-Non-ferro	34 -MgZn5 cast	
12	Cover, housing	0,00	2-TecPlastics	13 -PC	No
13	Backcover, housing	25,00	4-Non-ferro	27 -Al sheet/extrusion	
14	Machining losses aluminum	100,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,30	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	8,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,05	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	1,50	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,50	8-Extra	115-Silicone	
20	**Mainboard**				
21	PCB substrate, 10-layers, 43cm²	*43,00*	8-Extra	105-FR4 PCB Ni/Au-Finish 10-layers per cm²	
22	CPU SoC (2cm² package size, 1,1cm² die size)	*1,10*	8-Extra	117-IC, SoC per cm² die area	
23	RAM, 4GB (2cm² package size, 3cm² die size)	*3,00*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, 128GB (1,5cm² package size, 4cm² total die size)	*4,00*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 7,5 mg)	7,50	5-Coating	42 -Au/Pt/Pd	
26	other ICs (4cm² total die size)	*4,00*	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 1,2 mg)	1,20	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,06	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,80	6-Electronics	49 -SMD/ LED's avg.	
30	coils	1,30	3-Ferro	25 -Ferrite	
31	various connectors, incl. SIM card slot, Board-to-board connectors, USB	1,70	6-Electronics	46 -slots / ext. ports	
32	additional gold connectors in mg	6,50	5-Coating	42 -Au/Pt/Pd	
33	steel sheets (EMI shields)	3,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,40	6-Electronics	53 -Solder SnAg4Cu0.5	
35	eSIM	*0,04*	8-Extra	120-Generic IC per 1cm² die area	
36	5G components (modem and antenna ICs)	*1,69*	8-Extra	120-Generic IC per 1cm² die area	
37	heat pipe	2,00	4-Non-ferro	31 -Cu tube/sheet	
38					

Bill of materials data includes aluminum machining losses to account for the high share of material milled out of extruded or die cast aluminium parts, in line with the analysis provided in Task 4.

Table 25 : Base Case 3 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-boards (components included above)**				
42	PCB substrate, 8-layers, 6cm²	*6,00*	8-Extra	104-FR4 PCB Ni/Au-Finish 8-layers per cm²	
43	**Flex boards (50cm²)**	*50,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cr	
44	solder on flex	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,05	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	1,00	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,80	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BlkPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	1,20	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,02	8-Extra	115-Silicone	
55	**Vibration alert**				
56	Magnet	0,20	8-Extra	116-NdFeB magnet	
57	other mechancial parts, incl. Tungsten	1,20	4-Non-ferro	31 -Cu tube/sheet	
58	**Front camera (4x)**				
59	Sensor chip, 0,4cm³	1,60	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (1mg)	4,00	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	1,20	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	2,40	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,80	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,04	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,40	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,40	8-Extra	116-NdFeB magnet	
67	cover	0,80	2-TecPlastics	14 -PMMA	No
68	glass	0,40	8-Extra	114-Glass per g	
69	**flash light**	0,10	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,3cm³	*0,30*	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,75mg)	0,75	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,30	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,10	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,005	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,05	4-Non-ferro	29 -Cu winding wire	
78	cover	0,10	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	2,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	1,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws**	0,50	4-Non-ferro	32 -CuZn38 cast	
83					

The weight of "8-Extra" parts is listed separately as weight conversion factors for the other material categories (at the top of Table 26).

Table 26 : Base Case 3 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	23,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	70,00	6-Electronics		
91	Display (covered under "8-Extra")	16,50	6-Electronics		
92	Glass	37,00	7-Misc.		
93	Silicone	0,52	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (40g)**				
98	Back housing (PC+ABS)	6,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	6,00	1-BlkPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots / ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (13cm²)	*13,00*	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	5,33	6-Electronics	45 -big caps & coils	
107	Capacitors	3,00	6-Electronics	45 -big caps & coils	
108	coils	0,30	3-Ferro	25 -Ferrite	
109	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
111	solder	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	10,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	
116	connectors	10,00	6-Electronics	46 -slots / ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	
122	speaker magnets	0,80	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (300 g)**				
129	Cardboard	230,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BlkPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132	Accessories packaging	20,00	2-TecPlastics	13 -PC	
133					
134					

3.4.2. Distribution

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption is a very likely scenario.

Table 27 : Base Case 3 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)		
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	60		1
209	Is it an installed appliance (e.g. boiler)?		NO	61		0
				63		1
210	Volume of packaged final product in m^3	in m3	0,000745	64		0
				65		1

3.4.3. Energy consumption

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 5, p. 17. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 8,99 g (not depicted in the screenshot below).

Table 28 : Base Case 3 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals	
226	ErP Product (service) Life in years	**3,50**	years		
	Electricity				
227	Active battery charge: Consumption per hour, cycle, setting, etc.	0,01140	kWh	10,4025	
228	Active battery charge: No. of hours, cycles, settings, etc. / year	912,50	hrs.		
229	Trickle charge: Consumption per hour	0,00050	kWh	1,73375	
230	Trickle charge: No. of hours / year	3467,50	hrs.		
231	Adapter no-load: Consumption per hour	0,00002	kWh	0,0876	
232	Adapter no-load: No. of hours / year	4380,00	hrs.		
	TOTAL over ErP Product Life	**0,0428**	**MWh (=000 kWh)**	66	

3.4.4. End-of-Life

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Reuse as stated before, means actually reuse outside of EU27. Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 3,5 years.

As part of the material entries in the BoM are aluminum machining losses, which in fact are post-industrial waste with an assumed high recycling rate and not as post-consumer waste, the recycling rate for non-ferro materials is adapted here.

Table 29 : Base Case 3 – End of life

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	3,5	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	38,571	38,571	0,0%	0,0%
255	product & aux. mass over service life, in g/unit	1056	1056	0,0%	0,0%
256	total mass sold, in t (1000 kg)	40,73667787	40,73622524	0,0%	0,0%

Pos nr	Per fraction (post-consumer)	1	2	3	4	5	6	7a	7b	7c	8	9	
		Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc., excluding refrigant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	TOTAL (CARG avg.)
257	current fraction, in % of total mass (or mg/unit Hg)	1,5%	4,7%	1,5%	14,6%	1,9%	13,7%	29,4%	0,0%	0,0	32,7%	0,0%	100,0%
258	fraction x years ago, in % of total mass	1,5%	4,7%	1,5%	14,6%	1,9%	13,7%	29,4%	0,0%	0,0	32,7%	0,0%	100,0%
259	CAGR per fraction r, in %	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	0,0%	
	current product mass in g	16	49	16	154	21	145	310	0	0	345	0	1056
260	stock-effect, total mass in g/unit	0	0	0	0	0	0	0	0	0,0	0	0	0
261	EoL available, total mass ('arisings') in g/unit	16	49	16	154	21	145	310	0	0,0	345	0	1056
262	EoL available, subtotals in g		65		190		145	310	0	0,0	345	0	1056
													AVG
263	EoL mass fraction to re-use, in %						10%					0%	10,0%
264	EoL mass fraction to (materials) recycling, in %	0%	0%	0%	57%	0%	20%	80%	0%	0%	20%	0%	43,1%
265	EoL mass fraction to (heat) recovery, in %	20%	20%	20%	0%	20%	0%	20%	0%	0%	0%	0%	7,1%
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0,0%
267	EoL mass fraction to landfill/missing/fugitive, in %	70%	70%	70%	33%	70%	70%	0%	0%	0%	70%	0%	42,8%
268	TOTAL	100%	100%	100%	100%	100%	100%	100%	0%	0%	100%	0%	103,0%
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	

3.4.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19. Costs include spare parts and labour costs.

The cost data does not include costs for mobile subscription, payed apps or similar. Although these costs are relevant for the business models of various parties and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 30 : Base Case 3 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**3,50**	years
B	Annual sales	38,57	mln. Units/year
C	EU Stock	135,00	mln. Units
D	Product price	1000,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	27,84	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	3,50	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.5. Base Case 4: Feature Phone

3.5.1. Bill of Materials

The Bill of Materials is split in handset (the actual mobile phone, Table 31 and Table 32), accessories sold in the same package, and packaging material as such (both in Table 33).

Table 31 : Base Case 4 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 4 - feature phone	Date	Author
	Products	03.11.2020	Fraunhofer IZM

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	**Total handset (85g)**				
2	Battery (1200mAh)	24,00	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	*1,50*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display 2,4" (16cm²), LCD	*16,00*	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,20	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	0,30	2-TecPlastics	14 -PMMA	
7	Display, OLED	*0,00*	8-Extra	113-AMOLED panel per cm²	
8	Display PCB (included in flex)	*0,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Display tray	3,00	2-TecPlastics	13 -PC	
10	Cover glass	3,00	2-TecPlastics	14 -PMMA	
11	Internal frame	5,00	1-BlkPlastics	11 -ABS	No
12	Front cover, housing	7,00	2-TecPlastics	13 -PC	No
13	Back cover, housing	10,00	2-TecPlastics	13 -PC	Yes
14	Machining losses aluminum	0,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,00	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	0,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,00	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	0,00	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,00	8-Extra	115-Silicone	
20	**Mainboard**				
21	PCB substrate, 4-layers, 50cm²	*50,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
22	CPU SoC (1cm² package size, 0,25cm² die size)	*0,25*	8-Extra	117-IC, SoC per cm² die area	
23	RAM, integrated	*0,00*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, 16MB (0,04cm² total die size)	*0,04*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 1 mg)	1,00	5-Coating	42 -Au/Pt/Pd	
26	other ICs (0,2cm² total die size)	*0,20*	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 0,05 mg)	0,05	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,01	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,20	6-Electronics	49 -SMD/ LED's avg.	
30	coils	0,20	3-Ferro	25 -Ferrite	
31	various connectors, incl. SIM card slot, Board-to-board connectors, USB	2,00	6-Electronics	46 -slots / ext. ports	
32	additional gold connectors in mg	2,50	5-Coating	42 -Au/Pt/Pd	
33	steel sheets (EMI shields)	4,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,10	6-Electronics	53 -Solder SnAg4Cu0.5	
35	eSIM	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
36	5G components (modem and antenna ICs)	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
37	heat pipe	0,00	4-Non-ferro	31 -Cu tube/sheet	
38	**key pad**	8,00	8-Extra	115-Silicone	
39					
40					

Table 32 : Base Case 4 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-board key pad (components included above)**				
42	PCB (20cm²)	*20,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cr	
43	**Flex boards (4cm²)**	*4,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cr	
44	solder on flex	0,02	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,00	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	0,80	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,60	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BlkPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	0,40	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,00	8-Extra	115-Silicone	
55	**Vibration alert**				
56	Magnet	0,20	8-Extra	116-NdFeB magnet	
57	other mechancial parts, incl. Tungsten	1,30	4-Non-ferro	31 -Cu tube/sheet	
58	**Front camera (1x)**				
59	Sensor chip, 0,2cm³	0,20	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (0,5mg)	0,50	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	0,30	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	0,60	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,20	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,01	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,10	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,10	8-Extra	116-NdFeB magnet	
67	cover	0,20	2-TecPlastics	14 -PMMA	No
68	glass	1,00	8-Extra	114-Glass per g	
69	**flash light**	0,10	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,2cm³	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,5mg)	0,00	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,00	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,00	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,000	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,00	4-Non-ferro	29 -Cu winding wire	
78	cover	0,00	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	0,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	0,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws**	1,00	4-Non-ferro	32 -CuZn38 cast	
83					

The weight of "8-Extra" parts is listed separately as weight conversion factors for the other material categories (at the top of Table 33).

Table 33 : Base Case 4 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	14,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	24,00	6-Electronics		
91	Display (covered under "8-Extra")	3,00	6-Electronics		
92	Glass	1,00	7-Misc.		
93	Silicone	8,00	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (40g)**				
98	Back housing (PC+ABS)	6,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	6,00	1-BlkPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots / ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (13cm²)	*13,00*	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	5,33	6-Electronics	45 -big caps & coils	
107	Capacitors	3,00	6-Electronics	45 -big caps & coils	
108	coils	0,30	3-Ferro	25 -Ferrite	
109	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
111	solder	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	10,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	
116	connectors	10,00	6-Electronics	46 -slots / ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	
122	speaker magnets	0,00	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (300 g)**				
129	Cardboard	250,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BlkPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132					

3.5.2. Distribution

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption might not be fully accurate: As innovation cycles for feature phones are not as short as for smartphones shipping by other means than air cargo might be a viable distribution strategy. The fact that most of the devices are produced outside Europe is nevertheless correct.

Table 34 : Base Case 4 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)		
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	60		1
209	Is it an installed appliance (e.g. boiler)?		NO	61		0
				63		1
210	Volume of packaged final product in m^3	in m3	0,000505	64		0
				65		1

3.5.3. *Energy consumption*

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 5, p. 17. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 6,15 g (not depicted in the screenshot below).

Table 35 : Base Case 4 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals		
226	ErP Product (service) Life in years	3,00	years			
	Electricity					
227	Active battery charge: Consumption per hour, cycle, setting, etc.	0,00308	kWh	2,8105		
228	Active battery charge: No. of hours, cycles, settings, etc. / year	912,50	hrs.			
229	Trickle charge: Consumption per hour	0,00050	kWh	2,28125		
230	Trickle charge: No. of hours / year	4562,50	hrs.			
231	Adapter no-load: Consumption per hour	0,00002	kWh	0,0876		
232	Adapter no-load: No. of hours / year	4380,00	hrs.			
	TOTAL over ErP Product Life	0,0155	MWh (=000 kWh)	66		

3.5.4. *End-of-Life*

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Reuse as stated before, means actually reuse outside of EU27. Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 3 years.

Table 36 : Base Case 4 – End of life

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	3	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	15,000	22,500	-33,3%	-12,6%
255	product & aux. mass over service life, in g/unit	621	621	0,0%	0,0%
256	total mass sold, in t (1000 kg)	9,31244745	13,96867118	-33,3%	-12,6%

Pos nr	Description	1	2	3	4	5	6	7a	7b	7c	8	9	
	Per fraction (post-consumer)	Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	*TOTAL (CARG avg.)*
257	current fraction, in % of total mass (or mg/unit Hg)	3,4%	9,2%	1,1%	3,4%	0,7%	12,0%	47,3%	0,0%	0,0	22,8%	0,0%	*100,0%*
258	fraction x years ago, in % of total mass	3,4%	9,2%	1,1%	3,4%	0,7%	12,0%	47,3%	0,0%	0,0	22,8%	0,0%	*100,0%*
259	CAGR per fraction r, in %	-12,6%	-12,6%	-12,6%	-12,6%	-12,6%	-12,6%	-12,6%	0,0%	0,0%	-12,6%	0,0%	
	current product mass in g	*21*	*57*	*7*	*21*	*4*	*75*	*294*	*0*	*0*	*142*	*0*	*621*
260	stock-effect, total mass in g/unit	-11	-29	-3	-11	-2	-37	-147	0	0,0	-71	0	*-310*
261	EoL available, total mass ('arisings') in g/unit	32	86	10	32	6	112	441	0	0,0	212	0	*931*
262	EoL available, subtotals in g		118		48		112	441	0	0,0	212	0	*931*
													AVG
263	EoL mass fraction to re-use, in %						10%					0%	*10,0%*
264	EoL mass fraction to (materials) recycling, in %	0%	0%	0%	0%	0%	20%	80%	0%	0%	20%	0%	*44,8%*
265	EoL mass fraction to (heat) recovery, in %	20%	20%	20%	20%	20%	0%	20%	0%	0%	0%	0%	*13,0%*
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	*0,0%*
267	EoL mass fraction to landfill/missing/fugitive, in %	70%	70%	70%	70%	70%	70%	0%	0%	0%	70%	0%	*36,9%*
268	TOTAL	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*100%*	*0%*	*0%*	*100%*	*0%*	*104,7%*
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	*avg*

3.5.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19. Costs include spare parts and labour costs.

The cost data does not include costs for mobile subscription. Although these costs are relevant for the business models of the telecom provider and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 37 : Base Case 4 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**3,00**	years
B	Annual sales	15,00	mln. Units/year
C	EU Stock	56,25	mln. Units
D	Product price	80,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	5,25	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	3,00	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.6. Base Case 5: DECT cordless landline phone, with charging cradle / base station

3.6.1. Bill of Materials

The Bill of Materials is split in handset (the actual cordless phone, Table 38 and Table 39), accessories, including the base station / charging cradle sold in the same package (Table 39 and Table 40), and packaging material as such (Table 40).

Table 38 : Base Case 5 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 5 - cordless phone Products		Date	Author
			03.11.2020	Fraunhofer IZM

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	**Total handset (105g)**				
2	Battery (2x AAA NiMH)	17,70	8-Extra	110-NiMH battery (AAA)	
3	Battery PCB (included in main circuitry)	*0,00*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display (10,9cm²), LCD	*10,90*	8-Extra	111-LCD display, smartphone, per cm²	
5	LED backlights	0,05	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	0,01	2-TecPlastics	14 -PMMA	
7	Display, OLED	*0,00*	8-Extra	113-AMOLED panel per cm²	
8	Display PCB (included in flex)	*0,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
9	Display tray	5,90	1-BlkPlastics	11 -ABS	
10	Cover glass	3,50	2-TecPlastics	14 -PMMA	
11	Internal frame	0,00	1-BlkPlastics	11 -ABS	No
12	Front cover, housing	13,30	1-BlkPlastics	11 -ABS	Yes
13	Back cover, housing	20,50	1-BlkPlastics	11 -ABS	Yes
14	Machining losses aluminum	0,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Aluminum anodizing (plating as proxy)	0,00	5-Coating	41 -Cu/Ni/Cr plating	
16	Steel parts	0,00	3-Ferro	26 -Stainless 18/8 coil	
17	Ni plating steel parts	0,00	5-Coating	41 -Cu/Ni/Cr plating	
18	Copper foils and shields	0,00	4-Non-ferro	31 -Cu tube/sheet	
19	Rubber sealings	0,00	8-Extra	115-Silicone	
20	**Mainboard (12,3g)**				
21	PCB substrate, 2-layers, 14 x 3,9 cm²	*55,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cı	
22	CPU QFN80 (1,44cm² package size, 0,25cm² die size)	*0,25*	8-Extra	117-IC, SoC per cm² die area	
23	RAM, integrated	*0,00*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
24	NAND, integrated	*0,00*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
25	SoC, RAM, NAND gold (entered as 1 mg)	1,00	5-Coating	42 -Au/Pt/Pd	
26	other ICs (0,1cm² total die size)	*0,10*	8-Extra	120-Generic IC per 1cm² die area	
27	other IC gold (entered as 0,005 mg)	0,01	5-Coating	42 -Au/Pt/Pd	
28	diodes	0,01	6-Electronics	48 -IC's avg., 1% Si	
29	passive components	0,02	6-Electronics	49 -SMD/ LED's avg.	
30	quartz crystal	0,10	6-Electronics	49 -SMD/ LED's avg.	
31	LEDs (12pcs)	0,05	6-Electronics	49 -SMD/ LED's avg.	
32	power connector	0,30	6-Electronics	46 -slots / ext. ports	
33	metal battery clamps	1,00	3-Ferro	26 -Stainless 18/8 coil	
34	solder	0,25	6-Electronics	53 -Solder SnAg4Cu0.5	
35	graphite		6-Electronics		
36	**keyboard**				
37	key pad	13,37	8-Extra	115-Silicone	
38	foil	0,62	2-TecPlastics	17 -Flex PUR	
39	small metal contact plates	0,18	3-Ferro	26 -Stainless 18/8 coil	
40					

As some entries are scaled by size, not weight, weight balances are introduced in the model for a correct calculation of total weights (part of Table 39).

Table 39 : Base Case 5 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**speakers, microphone**				
42	Metal cover, springs	1,68	3-Ferro	26 -Stainless 18/8 coil	
43	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
44	Plastic housing	3,46	2-TecPlastics	13 -PC	No
45	Membrane foil	0,08	1-BlkPlastics	10 -PET	No
46	Copper coil	0,09	4-Non-ferro	29 -Cu winding wire	
47	Magnet	3,83	8-Extra	116-NdFeB magnet	
48	Rubber adhesive	0,02	8-Extra	115-Silicone	
49					
50	Sub-board key pad (none)				
51	Flex boards (none)				
52	Vibration alert (none)				
53	camera (none)				
54					
55	**Weight balance for materials covered under 8-Extra:**				
56	Electronics (weight of electronics covered under "8-Extra" scaled by a	9,20	6-Electronics		
57	Battery weight (covered under "8-Extra")	17,70	6-Electronics		
58	Display (covered under "8-Extra")	5,70	6-Electronics		
59	Magnets	3,83	7-Misc.		
60	Silicone	13,40	2-TecPlastics		
61					
62	**Charging / base station (160 g)**				
63	Front housing (ABS)	48,40	1-BlkPlastics	11 -ABS	Yes
64	Back housing (ABS)	41,10	1-BlkPlastics	11 -ABS	Yes
65	Telephone keyboard	17,10	8-Extra	115-Silicone	
66	Screws	2,40	3-Ferro	23 -St tube/profile	
67	3 metal clips (front housing)	0,90	3-Ferro	26 -Stainless 18/8 coil	
68	**Loudspeaker (6,3 g)**				
69	Plastic housing	2,735	1-BlkPlastics	11 -ABS	No
70	Membrane foil	0,07	1-BlkPlastics	2 -HDPE	No
71	Copper coil	0,06	4-Non-ferro	29 -Cu winding wire	
72	Metal springs	0,17	3-Ferro	26 -Stainless 18/8 coil	
73	Magnet	2,67	8-Extra	116-NdFeB magnet	
74	Metal cover	0,56	3-Ferro	26 -Stainless 18/8 coil	
75	**PCB assembly (9,5 cm x 7,2 cm x 0,1 cm) (L x B x H) (21,0 g)**				
76	PCB	16,16	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cr	
77	CPU	0,20	8-Extra	120-Generic IC per 1cm² die area	
78	other ICs	0,40	6-Electronics	48 -IC's avg., 1% Si	
79	quartz crystal, passive components and LEDs (2pcs)	0,50	6-Electronics	49 -SMD/ LED's avg.	
80	solder	0,40	6-Electronics	53 -Solder SnAg4Cu0.5	
81	Plugs	3,29	6-Electronics	46 -slots / ext. ports	
82					
83	**Telephone plug (25,2 g)**				
84	Plugs	5,18	6-Electronics	46 -slots / ext. ports	
85	Cable sheath	9,985	1-BlkPlastics	8 -PVC	No
86	Wires	9,985	4-Non-ferro	30 -Cu wire	
87					

Table 40 : Base Case 5 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**power adapter (60g)**				
89	Back housing (PC+ABS)	10,60	2-TecPlastics	13 -PC	No
90	Front housing (PC+ABS)	10,00	1-BlkPlastics	11 -ABS	No
91	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
92	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
93	Screws	0,60	3-Ferro	26 -Stainless 18/8 coil	
94	Cable sheath	10,000	1-BlkPlastics	8 -PVC	
95	Wire	10,000	4-Non-ferro	30 -Cu wire	
96	Plug	1,353	6-Electronics	46 -slots / ext. ports	
97	**PCB assembly (4,4 cm x 2,9 cm x 0,15 cm) (L x B x H) (12,9 g)**				
98	PCB, THT/SMD, single-sided	*12,76*	8-Extra	107-FR4 PCB HAL-Finish 1-layer per cm²	
99	Coil	5,333	6-Electronics	45 -big caps & coils	
100	Capacitors	3,00	6-Electronics	45 -big caps & coils	
101	small ICs	0,15	6-Electronics	48 -IC's avg., 1% Si	
102	passive components (SMD)	0,05	6-Electronics	49 -SMD/ LED's avg.	
103					
104	**Weight balance for accessories materials covered under 8-Extra:**				
105	Electronics (weight of electronics covered under "8-Extra" scaled by a	20,50	6-Electronics		
106	Magnets	2,67	7-Misc.		
107	Silicone	17,10	2-TecPlastics		
108					
109					
110					
111					
112					
113	**Package (120 g)**				
114	Cardboard (22 cm x 16,1 cm x 6,5 cm) (L x B x H)	92,70	7-Misc.	57 -Cardboard	
115	Plastic bags	6,40	1-BlkPlastics	1 -LDPE	
116	Manual	22,30	7-Misc.	58 -Office paper	
117	Plastic parts	0,50	1-BlkPlastics	1 -LDPE	
118					

3.6.2. Distribution

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption might not be fully accurate: As innovation cycles for cordless phones are not as short as for smartphones shipping by other means than air cargo might be a viable distribution strategy. Furthermore there is still a relevant manufacturing base for cordless phones in Europe. The modelling as intercontinental air cargo thus overestimates actual distribution impacts.

Table 41 : Base Case 5 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)	
208	**Is it an ICT or Consumer Electronics product <15 kg ?**		YES	60	1
209	**Is it an installed appliance (e.g. boiler)?**		NO	61	0
				63	1
210	**Volume of packaged final product in m³**	in m3	0,00229	64	0
				65	1

3.6.3. Energy consumption

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 7, p. 18. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 5,95 g (not depicted in the screenshot below).

Table 42 : Base Case 5 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals	
226	ErP Product (service) Life in years	5,00	years		
	Electricity				
227	Active mode: Consumption per hour, cycle, setting, etc.	0,00150	kWh	0,0876	
228	Active mode: No. of hours, cycles, settings, etc. / year	58,40	hrs.		
229	Active battery charge: Consumption per hour, cycle, setting, etc.	0,00100	kWh	0,027375	
230	Active battery charge: No. of hours, cycles, settings, etc. / year	27,38	hrs.		
231	Standby mode: Consumption per hour	0,00060	kWh	5,204535	
232	Standby mode: No. of hours / year	8674,23	hrs.		
	TOTAL over ErP Product Life	0,0266	MWh (=000 kWh)	66	

3.6.4. End-of-Life

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 5 years and reuse outside the EU27 is not considered relevant for this base case.

End of life rates correspond to the scenario defined in Task 4.

Table 43 : Base Case 5 – End of life

Pos nr	DISPOSAL & RECYCLING Description				
253	product (stock) life L, in years	5	Please edit values with red font		
		current	L years ago	period growth PG in %	CAGR in %/a
254	unit sales in million units/year	13,800	16,900	-18,3%	-4,0%
255	product & aux. mass over service life, in g/unit	601	601	0,0%	0,0%
256	total mass sold, in t (1000 kg)	8,29722171	10,16109036	-18,3%	-4,0%

Pos nr	Per fraction (post-consumer)	1	2	3	4	5	6	7a	7b	7c	8	9	
		Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	TOTAL (CARG avg.)
257	current fraction, in % of total mass (or mg/unit Hg)	28,4%	8,2%	1,3%	4,0%	0,2%	12,4%	20,4%	0,0%	0,0	25,2%	0,0%	100,0%
258	fraction x years ago, in % of total mass	28,4%	8,2%	1,3%	4,0%	0,2%	12,4%	20,4%	0,0%	0,0	25,2%	0,0%	100,0%
259	CAGR per fraction r, in %	-4,0%	-4,0%	-4,0%	-4,0%	-4,0%	-4,0%	-4,0%	0,0%	0,0%	-4,0%	0,0%	
	current product mass in g	*171*	*49*	*8*	*24*	*1*	*74*	*123*	*0*	*0*	*152*	*0*	*601*
260	stock-effect, total mass in g/unit	-38	-11	-2	-5	0	-17	-28	0	0,0	-34	0	-135
261	EoL available, total mass ('arisings') in g/unit	209	60	10	29	1	91	150	0	0,0	186	0	736
262	EoL available, subtotals in g		269		40		91	150	0	0,0	186	0	736

Pos nr	Description	1	2	3	4	5	6	7a	7b	7c	8	9	AVG
263	EoL mass fraction to re-use, in %						0%					0%	0,0%
264	EoL mass fraction to (materials) recycling, in %	50%	50%	50%	50%	50%	50%	80%	0%	0%	50%	0%	56,1%
265	EoL mass fraction to (heat) recovery, in %	0%	0%	0%	0%	0%	0%	20%	0%	0%	0%	0%	4,1%
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0,0%
267	EoL mass fraction to landfill/missing/fugitive, in %	50%	50%	50%	50%	50%	50%	0%	0%	0%	50%	0%	39,8%
268	TOTAL	100%	100%	100%	100%	100%	100%	100%	0%	0%	100%	0%	100,0%
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	

3.6.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19. This includes a battery replacement by the user in 50% of the cases.

The cost data does not include costs for landline subscription. Although these costs are relevant for the business models of the telecom provider and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 44 : Base Case 5 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**5,00**	years
B	Annual sales	13,80	mln. Units/year
C	EU Stock	72,40	mln. Units
D	Product price	50,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	3,50	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	5,00	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.7. Base Case 6: Tablet (no attached keyboard)

3.7.1. Bill of Materials

The Bill of Materials is split in the end device (the actual tablet computer, Table 45 and Table 46), accessories sold in the same package, and packaging material as such (both in Table 47).

Table 45 : Base Case 6 – Product specific inputs, Bill of Materials (part 1)

Nr	Base Case 6 - tablet		Date	Author
	Products		03.11.2020	Fraunhofer IZM

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
1	**Total tablet (600g)**				
2	Battery (6000mAh)	100,00	8-Extra	109-LCO-Battery (Lithium-Cobalt-Oxid)	
3	Battery PCB	*2,50*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
4	Display, LCD (11", 337cm²)	*336,96*	8-Extra	112-LCD display, tablet, per cm²	
5	LED backlights	0,80	6-Electronics	49 -SMD/ LED's avg.	
6	Light guide panel	4,00	2-TecPlastics	14 -PMMA	
7	Display PCB	*3,00*	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
8	Display back side	30,00	4-Non-ferro	27 -Al sheet/extrusion	
9	Cover glass	95,00	8-Extra	114-Glass per g	
10	Midframe (Mg)	20,00	4-Non-ferro	34 -MgZn5 cast	
11	Back cover, housing	30,00	2-TecPlastics	13 -PC	No
12	Back cover, housing	20,00	1-BlkPlastics	11 -ABS	No
13	Back cover, plastics plating for shielding purposes	0,02	5-Coating	41 -Cu/Ni/Cr plating	
14	Back cover, housing (50% forged; 50% CNC machined)	60,00	4-Non-ferro	27 -Al sheet/extrusion	
15	Machining losses aluminum	120,00	4-Non-ferro	27 -Al sheet/extrusion	
16	Aluminum anodizing (plating as proxy)	1,00	5-Coating	41 -Cu/Ni/Cr plating	
17	Steel parts	10,00	3-Ferro	26 -Stainless 18/8 coil	
18	Ni plating steel parts	0,05	5-Coating	41 -Cu/Ni/Cr plating	
19	Copper foils and shields	4,00	4-Non-ferro	31 -Cu tube/sheet	
20	Rubber sealings	1,00	8-Extra	115-Silicone	
21	**Mainboard**				
22	PCB substrate, 6-layers, 80cm²+20cm² odd-form cut-offs	*100,00*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
23	CPU SoC (1,5cm² package size, 0,8cm² die size)	*0,80*	8-Extra	117-IC, SoC per cm² die area	
24	RAM, 4GB (2cm² package size, 3cm² die size)	*3,00*	8-Extra	118-IC, DRAM (50% of SoC) per 1cm² die area	
25	NAND, 64GB (1,5cm² package size, 3cm² total die size)	*3,00*	8-Extra	119-IC, NAND (60% of SoC) per 1cm² die area	
26	SoC, RAM, NAND gold (entered as 6,5 mg)	6,50	5-Coating	42 -Au/Pt/Pd	
27	other ICs (2cm² total die size), less RF than phones	*2,00*	8-Extra	120-Generic IC per 1cm² die area	
28	other IC gold (entered as 0,6 mg)	0,60	5-Coating	42 -Au/Pt/Pd	
29	diodes	0,05	6-Electronics	48 -IC's avg., 1% Si	
30	passive components	0,60	6-Electronics	49 -SMD/ LED's avg.	
31	coils	1,20	3-Ferro	25 -Ferrite	
32	various connectors, incl. SIM card slot, Board-to-board connectors, USB	1,00	6-Electronics	46 -slots / ext. ports	
33	additional gold connectors in mg	4,00	5-Coating	42 -Au/Pt/Pd	
34	steel sheets (EMI shields)	5,00	3-Ferro	26 -Stainless 18/8 coil	
35	solder	0,80	6-Electronics	53 -Solder SnAg4Cu0.5	
36	eSIM	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
37	5G components (modem and antenna ICs)	*0,00*	8-Extra	120-Generic IC per 1cm² die area	
38	heat pipe	1,00	4-Non-ferro	31 -Cu tube/sheet	
39					
40					

Bill of materials data includes aluminum machining losses to account for the high share of material milled out of extruded or die cast aluminium parts, in line with the analysis provided in Task 4.

Table 46 : Base Case 6 – Product specific inputs, Bill of Materials (part 2)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
41	**Sub-boards (components included above)**				
42	PCB substrate, 6-layers, 6cm²	*6,00*	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
43	**Flex boards (60cm²)**	*60,00*	8-Extra	101-Flex PCB Ni/Au-Finish 1-layer, double-sided per cı	
44	solder on flex	0,50	6-Electronics	53 -Solder SnAg4Cu0.5	
45	passive components on flex	0,05	6-Electronics	49 -SMD/ LED's avg.	
46	**speakers, microphone**				
47	Metal cover	1,00	3-Ferro	26 -Stainless 18/8 coil	
48	Plating	0,01	5-Coating	41 -Cu/Ni/Cr plating	
49	Plastic adhesive	0,01	2-TecPlastics	17 -Flex PUR	No
50	Plastic housing	0,80	2-TecPlastics	13 -PC	No
51	Membrane foil	0,01	1-BlkPlastics	10 -PET	No
52	Copper coil	0,04	4-Non-ferro	29 -Cu winding wire	
53	Magnet	1,20	8-Extra	116-NdFeB magnet	
54	Rubber adhesive	0,02	8-Extra	115-Silicone	
55					
56					
57					
58	**Front camera (1x)**				
59	Sensor chip, 0,3cm³	0,30	8-Extra	120-Generic IC per 1cm² die area	
60	Gold bond wires (1mg)	0,80	5-Coating	42 -Au/Pt/Pd	
61	PCB, 6-layers; flex included above	0,30	8-Extra	103-FR4 PCB Ni/Au-Finish 6-layers per cm²	
62	aluminum	0,60	4-Non-ferro	27 -Al sheet/extrusion	
63	steel	0,20	3-Ferro	26 -Stainless 18/8 coil	
64	plating steel parts	0,01	5-Coating	41 -Cu/Ni/Cr plating	
65	copper	0,10	4-Non-ferro	29 -Cu winding wire	
66	magnets	0,10	8-Extra	116-NdFeB magnet	
67	cover	0,20	2-TecPlastics	14 -PMMA	No
68	glass	0,10	8-Extra	114-Glass per g	
69	**flash light**	0,05	6-Electronics	49 -SMD/ LED's avg.	
70	**Rear camera**				
71	Sensor chip, 0,2cm³	*0,20*	8-Extra	120-Generic IC per 1cm² die area	
72	Gold bond wires (0,75mg)	0,50	5-Coating	42 -Au/Pt/Pd	
73	flex included above	0,00			
74	aluminum	0,30	4-Non-ferro	27 -Al sheet/extrusion	
75	steel	0,10	3-Ferro	26 -Stainless 18/8 coil	
76	plating steel parts	0,005	5-Coating	41 -Cu/Ni/Cr plating	
77	copper	0,05	4-Non-ferro	29 -Cu winding wire	
78	cover	0,10	2-TecPlastics	14 -PMMA	No
79	**Wireless charging coil**				
80	foil	0,00	2-TecPlastics	17 -Flex PUR	No
81	copper coil	0,00	4-Non-ferro	29 -Cu winding wire	
82	**Screws and winding inlays**	3,50	4-Non-ferro	32 -CuZn38 cast	
83					

The weight of “8-Extra” parts is listed separately as weight conversion factors for the other material categories (at the top of Table 47).

Table 47 : Base Case 6 – Product specific inputs, Bill of Materials (part 3)

Pos nr	MATERIALS Extraction & Production Description of component	Weight in g	Category Click &select	Material or Process select Category first !	Recyclable?
88	**Weight balance for materials covered under 8-Extra:**				
89	Electronics (weight of electronics covered under "8-Extra" scaled by a	30,00	6-Electronics		
90	Battery weight (covered under "8-Extra")	100,00	6-Electronics		
91	Display (covered under "8-Extra")	60,00	6-Electronics		
92	Glass	95,00	7-Misc.		
93	Silicone	1,02	2-TecPlastics		
94					
95					
96	**ACCESSORIES**				
97	**power adapter (80g)**				
98	Back housing (PC+ABS)	19,00	2-TecPlastics	13 -PC	No
99	Front housing (PC+ABS)	19,00	1-BlkPlastics	11 -ABS	No
100	Plugs	3,40	4-Non-ferro	32 -CuZn38 cast	
101	Metal clips	0,50	3-Ferro	26 -Stainless 18/8 coil	
102	Screws	1,20	3-Ferro	26 -Stainless 18/8 coil	
103	USB Connector	1,40	6-Electronics	46 -slots / ext. ports	
104	**power adapter PCB assembly**				
105	PCB, THT/SMD, single-sided (18cm²)	*18,00*	8-Extra	108-FR4 PCB HAL-Finish 1-layer, double-sided per cm²	
106	Coil	10,00	6-Electronics	45 -big caps & coils	
107	Capacitors	7,00	6-Electronics	45 -big caps & coils	
108	Coils	2,00	3-Ferro	25 -Ferrite	
109	small ICs	0,30	6-Electronics	48 -IC's avg., 1% Si	
110	passive components (SMD)	0,10	6-Electronics	49 -SMD/ LED's avg.	
111	solder	2,00	6-Electronics	53 -Solder SnAg4Cu0.5	
112	Electronics (weight of electronics covered under "8-Extra" scaled by a	14,00	6-Electronics		
113	**USB cable (25g)**				
114	cable (wire)	7,50	4-Non-ferro	30 -Cu wire	
115	cable (PPE insulation)	7,50	2-TecPlastics	12 -PA 6	
116	connectors	10,00	6-Electronics	46 -slots / ext. ports	
117					
118	**Headset (20g)**				
119	cable (wire)	4,00	4-Non-ferro	30 -Cu wire	
120	cable (PPE insulation)	4,00	2-TecPlastics	12 -PA 6	
121	earpiece	7,00	2-TecPlastics	13 -PC	
122	speaker magnets	0,80	8-Extra	115-NdFeB magnet	
123	copper coil	0,20	4-Non-ferro	30 -Cu wire	
124	PCB remote (1cm²)	1,00	8-Extra	102-FR4 PCB Ni/Au-Finish 4-layers per cm²	
125	headset plug	3,00	4-Non-ferro	32 -CuZn38 cast	
126					
127					
128	**Package (600 g)**				
129	Cardboard	550,00	7-Misc.	57 -Cardboard	
130	Plastic foil	10,00	1-BlkPlastics	1 -LDPE	Yes
131	Manual, printed product information	40,00	7-Misc.	58 -Office paper	
132					

3.7.2. Distribution

The EcoReport template distinguishes ICT and consumer electronics <15kg and other ErP. The underlying assumption is that small ICT and consumer electronics products are shipped mainly through air cargo and are produced outside Europe typically. For this base case this assumption is a very likely scenario.

Table 48 : Base Case 6 – Distribution settings

Pos nr	DISTRIBUTION (incl. Final Assembly) Description		Answer	Category index (fixed)		
208	Is it an ICT or Consumer Electronics product <15 kg ?		YES	60		1
209	Is it an installed appliance (e.g. boiler)?		NO	61		0
				63		1
210	Volume of packaged final product in m³	in m3	0,002035	64		0
				65		1

3.7.3. Energy consumption

All modes are modelled with kWh per h in this mode. Power consumption data is as stated in Table 5, p. 17. Spare parts by default are accounted for with 1% of the production and manufacturing impact and spare parts weight of 20,74 g (not depicted in the screenshot below).

Table 49 : Base Case 6 – Energy consumption

Pos nr	USE PHASE direct ErP impact Description		unit	Subtotals	
226	ErP Product (service) Life in years	5,00	years		
	Electricity				
227	Active battery charge: Consumption per hour, cycle, setting, etc.	0,00760	kWh	6,935	
228	Active battery charge: No. of hours, cycles, settings, etc. / year	912,50	hrs.		
229	Trickle charge: Consumption per hour	0,00050	kWh	1,73375	
230	Trickle charge: No. of hours / year	3467,50	hrs.		
231	Adapter no-load: Consumption per hour	0,00002	kWh	0,0876	
232	Adapter no-load: No. of hours / year	4380,00	hrs.		
	TOTAL over ErP Product Life	0,0438	MWh (=000 kWh)		66

3.7.4. End-of-Life

As material entries under miscellaneous are mainly packaging materials (cardboard, paper) a higher recycling rate is assumed, corresponding with paper packaging waste.

Reuse as stated before, means actually reuse outside of EU27. Typical cascade reuse, re-commerce within the European Union and consumer-to-consumer resale is covered by the product lifetime of 5 years.

As part of the material entries in the BoM are aluminum machining losses, which in fact are post-industrial waste with an assumed high recycling rate and not as post-consumer waste, the recycling rate for non-ferro materials is adapted here.

Table 50 : Base Case 6 – End of life

Pos nr	DISPOSAL & RECYCLING Description					
253	product (stock) life L, in years	5	Please edit values with red font			
		current	L years ago	period growth PG in %	CAGR in %/a	
254	unit sales in million units/year	23,900	41,600	-42,5%	-10,5%	
255	product & aux. mass over service life, in g/unit	2095	2095	0,0%	0,0%	
256	total mass sold, in t (1000 kg)	50,06319975	87,13929328	-42,5%	-10,5%	

Pos nr	Per fraction (post-consumer)	1	2	3	4	5	6	7a	7b	7c	8	9	
		Bulk Plastics	TecPlastics	Ferro	Non-ferro	Coating	Electronics	Misc. , excluding refrigerant & Hg	refrigerant	Hg (mercury), in mg/unit	Extra	Auxiliaries	TOTAL (CARG avg.)
257	current fraction, in % of total mass (or mg/unit Hg)	2,4%	3,6%	1,0%	12,4%	0,7%	11,5%	33,0%	0,0%	0,0	35,5%	0,0%	100,0%
258	fraction x years ago, in % of total mass	2,4%	3,6%	1,0%	12,4%	0,7%	11,5%	33,0%	0,0%	0,0	35,5%	0,0%	100,0%
259	CAGR per fraction r, in %	-10,5%	-10,5%	-10,5%	-10,5%	-10,5%	-10,5%	-10,5%	0,0%	0,0%	-10,5%	0,0%	
	current product mass in g	*50*	*74*	*21*	*260*	*14*	*241*	*692*	*0*	*0*	*743*	*0*	*2095*
260	stock-effect, total mass in g/unit	-37	-55	-16	-193	-10	-179	-512	0	0,0	-550	0	-1551
261	EoL available, total mass ('arisings') in g/unit	86	129	37	453	24	420	1204	0	0,0	1293	0	3646
262	EoL available, subtotals in g		216		514		420	1204	0	0,0	1293	0	3646
													AVG
263	EoL mass fraction to re-use, in %						10%					0%	10,0%
264	EoL mass fraction to (materials) recycling, in %	0%	0%	0%	57%	0%	20%	80%	0%	0%	20%	0%	43,9%
265	EoL mass fraction to (heat) recovery, in %	20%	20%	20%	0%	20%	0%	20%	0%	0%	0%	0%	7,8%
266	EoL mass fraction to non-recov. incineration, in %	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0,0%
267	EoL mass fraction to landfill/missing/fugitive, in %	70%	70%	70%	33%	70%	70%	0%	0%	0%	70%	0%	41,7%
268	TOTAL	100%	100%	100%	100%	100%	100%	100%	0%	0%	100%	0%	103,3%
269	EoL recyclability****, (click& select: 'best', '>avg', 'avg' (basecase); '< avg'.; 'worst')	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg	avg
		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	

3.7.5. Economic data

Repair costs reflect the repair scenario summarised in Table 8, page 19. Costs include spare parts and labour costs.

The cost data does not include costs for mobile subscription, payed apps or similar. Although these costs are relevant for the business models of various parties and also for the consumer they are considered irrelevant for the later life cycle costing of design options.

Table 51 : Base Case 6 – Economic data

nr	INPUTS FOR EU-Totals & economic Life Cycle Costs Description		unit
A	Product Life	**5,00**	years
B	Annual sales	23,90	mln. Units/year
C	EU Stock	150,50	mln. Units
D	Product price	330,00	Euro/unit
E	Installation/acquisition costs (if any)		Euro/ unit
F	Fuel rate (gas, oil, wood)		Euro/GJ
G	Electricity rate	0,21	Euro/kWh
H	Water rate		Euro/m3
I	Aux. 1: None		Euro/kg
J	Aux. 2 :None		Euro/kg
K	Aux. 3: None		Euro/kg
L	Repair & maintenance costs	16,50	Euro/ unit
M	Discount rate (interest minus inflation)	0,04	%
N	Escalation rate (project annual growth of running costs)	0,04	%
O	Present Worth Factor (PWF) (calculated automatically)	5,00	(years)
P	Ratio efficiency STOCK: efficiency NEW, in Use Phase	1,00	

3.8. Specific new data sets

As small ICT products are characterised by an ecological profile, which is determined by electronics components and some other specific parts, it is important for the overall analysis that the background data properly reflects latest manufacturing data. The generic data used in the MEErP EcoReport tool is dated before 2005 and typically underestimates electronics components: The intention to base all datasets on weight as the scaling parameter lead to impact values which neglect miniaturisation effects. We therefore had to update several data sets to reflect actual impacts better.

Data sources and assumptions in the 2005 MEEuP documentation (Kemna et al. 2005) of background data is as follows, including a revised modelling approach applied in this study to reflect the specifics of this product group[3]:

[row 43 – LCD per m² scrn] An LCD is mainly a semi-conductor (8-9 layers, 4-5 masks) on glass substrate (0.7mm), covered by another glass 0.7 mm panel with colour filters. The energy consumption data relate to state-of-the-art 6G plant 2005 (source Sharp Corp., Japan), using a cogeneration power plant and extensive recycling (100% water and waste recycling) and scrubbing facilities. As a consequence Sharp Corp. data for GWP from PFCs are a fraction of what was previously indicated for 4G and 5G fabs in 2003 and should be robust for the immediate future. The data are including glass production (IPPC BREF source) and include an indicative figure (0.12 GJ oil, emissions and resources according to row 72) for extraction & transportation of fuels for the

[3] Row numbers updated according to minor re-arrangements in MEErP 2014

cogeneration plant. Data are in m² viewable screen size. Conversion with density 2.76 g/ml (BSi glass) 1 m² = 3.86 kg. (Kemna et al. 2005)

New: [rows 111 - LCD display, smartphone, per cm²; 112 - LCD display, tablet, per cm²] Latest data from one of the larger display manufacturers (AU Optronics Corp. 2020) has been re-modelled, including assumptions for current manufacturing yield in LCD manufacturing (representing a maturity level reached after several months of production). To account for the specifics of smartphone displays (manufactured on smaller glass panels in less efficient fabs than the larger TV display panels, higher complexity of the process) two LCD datasets are introduced, an LCD, tablets, dataset and an LCD, smartphones, dataset with an assumed 20% higher impact across all impact categories.

New: [row 113 - AMOLED panel per cm²] OLED is the dominating display technology for high-end phones, increasingly entering also the mid-range market. As materials and manufacturing of the light-emitting structures are different than LCD technology, but some processes regarding the substrates are similar, OLED data on Primary Energy Demand and Global warming Potential is retrieved from literature data on AMOLED technology (Amasawa et al. 2016), reflecting an estimation for large scale manufacturing conditions. As the data includes yields for chemical reactions but no manufacturing yields the same yield as for LCD displays has been assumed. As data for indicators other than PED and GWP is not provided by Amasawa the same data as for LCD, smartphones, has been applied.

[row 45 - slots / ext. ports] PWB-mounted slots for RAM-chips, PCI cards + external ports. VHK estimate based on materials fractions. Per 1000 g: Cu alloy pins 330 g+5 g Cu/Ni plated + 635 g polymer+0.15 g Au. (Kemna et al. 2005)

This dataset is used for external and internal connectors. Due to the miniature dimensions a higher relative gold content is reflected by adding additional gold through the gold plating dataset.

[rows 46 - large IC; 47 – small IC] Based on Si wafer 200 mm diameter, 20 layer complexity. Following ESIA-indications (European Semi-conductor Industry Ass.) we used SemaTech 2002 data of 499 kWh electricity use per wafer and a yield of 44 g of core material per wafer (11.34 kWh/g). At 5% core material per IC this results in 567 kWh per kg of IC. Back-end production is adding 25%, leading to 709 kWh electricity per kg of IC. To this a gold content of 0.2 % is added (avg. for larger IC, incl. memory), see row 41 +25%. For small SMD-type ICs we assume 1 wt. % core material and 0.1 wt. % gold content. For non-electricity related emissions sustainability reports of individual manufacturers were used. More in general, the two indicated data-sets for 1% and 5% core-material (=actual die, silicon, without lid) roughly represent extremes of the current range of ICs. (Kemna et al. 2005)

As for smartphones are major drivers for innovations in semiconductors nowadays it is important to reflect latest technology developments. Re-modelled semiconductor datasets are based on data by highly relevant semiconductor manufacturers (TSMC 2019; Intel 2020). Data furthermore is scaled per cm² of die area, which is the much more accurate scaling parameter than the packaged IC weight as applied in the standard EcoReport datasets. This is particularly the case for storage chips where several dice are stacked in one package and actually the package size (and weight) is actually the same across all storage specs, but differing in size of integrated semiconductor area. Data for upstream wafer manufacturing is based on industry data compiled in ongoing research projects (Gröger et al. 2020; Stobbe 2020).

New: [row 117 - IC, SoC per cm² die area] Smartphone processors are Systems-on-Chip representing extreme complexity in the semiconductor industry. Also the packaging technology, which is a wafel level packaging process with several redistribution layers

(RDLs), is much more complex than “conventional” wire bonding on leadframe. The environmental indicators are calculated with TSMC data, plus an adder to reflect the above-average complexity. Reference is a cm² of processed die, which already includes the packaging process.

New: [row 118 – IC, DRAM (50% of SoC) per 1cm² die area] DRAM is less complex than SoC and calculated with 50% of the SoC impact as a proxy. Packaging / back-end processes included. Gold for wire bonds is added separately through the gold coating dataset.

New: [row 119 - IC, NAND (60% of SoC) per 1cm² die area] NAND Flash storage is a less complex process than for SoC. Latest NAND multi-layer technology (Maejima et al. 2018) however adds additional manufacturing processes to create 3-dimensional memory cells. This has partly been achieved even by bonding two processed wafers together. Furthermore staking dice in a thin package requires thinning of wafers, which roughly represents a 5-10% adder of environmental impacts on top of the processing impacts, which is also a fact indicating that scaling by weight is not the correct approach here. Overall, this specific NAND Flash memory dataset is scaled with 60% of the SoC impact. Gold for wire bonds is added separately through the gold coating dataset.

New: [row 120 - Generic IC per 1cm² die area] All other semiconductors, in particular for the radio functions are highly complex components as well. To balance out the above-average impact of the SoCs this generic dataset is modelled with 95% of the average TSMC data. Gold for wire bonds is added separately through the gold coating dataset.

[row 50 - PWB 1/2 lay 3.75kg/m2] Standard FR4 (density 1.9) board with 1 or 2 Cu foils 35 µm thick. Overall board thickness 1.5 mm, assumed density 2.5 g/ml. 1 m² = 3.75 kg. Manufacturing energy 440 MJ + materials energy 490 MJ = 930 MJ/m² . 248 MJ/kg. Typical PWB for appliances and motor controllers.[data: AT&S + standard Unit Indicator values for Cu, E-glass, epoxy, etc. for materials inputs]. (Kemna et al. 2005)

*[row 51 - PWB 6 lay 4.5 kg/m2] Multilayer standard FR4 (density 1.9) board resin (EP 30%-GF, 125 MJ/kg) with 2 external Cu foils 35 µg thick and 4 internal Cu layers of 18 µg. Overall board thickness 1.5 mm and assumed density 3 g/ml. 1 m² = 4.5 kg. Manufacturing energy 540 MJ/m² + materials energy 4.5*130=585 MJ/m² . Total 1125 MJ/m² 250 MJ/kg. Typical PWB (also in 3-4 layer version) for PC Desktop mainboards, TVs, etc. [source as row 50]*

[row 52 PWB 6 lay 2 kg/m2] Multilayer board with microvias, resin (141 MJ/kg, 1.1 MJ/kg) aramid filled (<1 mm thick, estimated 30 vol% non-woven aramid at 250 MJ/kg, 1.6 g/ml). Assumed overall thickness 0.9 mm. Cu (143 MJ/kg) foils 9 um per layer internal (assumed 6 layer= total 60 um). Ni finish. Density excl. Cu 1.4 g/ml; Density incl. Cu 2 g/ml 2 kg/m². Manufacturing 375 MJ/m² + materials ca. 300 MJ/m² . Total 675 MJ/m² 337 MJ/kg. Typical PWB for mobile products (laptop, cell phone). [source as row 50]

Data on PCBs has been revised completely to reflect better the various types of PCBs found in mobile phones and tablets and to introduce a scaling by area instead of weight. Raw materials have a significant impact on overall environmental impacts, but more important is the processed area in PCB manufacturing (Schischke et al. 2013). Data on PCBs is derived from a European project (Project LCA to go 2014) and has been checked against more recent industry data.

New: [rows 100 - Flex PCB Ni/Au-Finish 1-layer per cm²; 101 - Flex PCB Ni/Au-Finish 1-layer, double-sided per cm²] Processing of rigid FR4 boards and flex printed circuit boards is very similar and results according to industry sources in similar environmental impacts. The ILCD dataset on FR4 rigid PCBs is therefore applicable as a proxy for the numerous flex boards in smartphones and tablets.

New: [rows 102 - FR4 PCB Ni/Au-Finish 4-layers per cm²; 103 - FR4 PCB Ni/Au-Finish 6-layers per cm²; 104 - FR4 PCB Ni/Au-Finish 8-layers per cm²] Data is derived from ILCD datasets.

New: [rows 105 - FR4 PCB Ni/Au-Finish 10-layers per cm²; 106 - FR4 PCB Ni/Au-Finish 12-layers per cm²] Data is scaled up from ILCD datasets, reflecting the addition of layers on a multi-layer board.

Several other datasets did not exist at all in the EcoReport template, but are deemed necessary for a better modelling of this specific product group:

New: [row 109 - LCO-Battery (Lithium-Cobalt-Oxid)] Reference: (Clemm et al. 2016)

New: [row 110 - NiMH battery (AAA)] Rechargeable NiMH batteries according to Comparative Life Cycle Environmental Impact Analysis of Lithium-Ion (LiIo) and Nickel-Metal Hydride (NiMH) Batteries (Mahmud et al. 2019). System boundary includes the battery production phase, which is cradle-to-gate. This analysis is done using SimaPro software version 8.5. The geographic region is Japan. It is assumed that the battery plant is in Japan, and the raw materials used, and the electricity in use is also produced on the Asian continent. Published environmental indicators include Primary Energy Demand (embodied energy), Global Warming Potential, Acidification, Eutrophication. For the other indicators data from the EcoReport dataset on big capacitors and coils [row 45] has been applied.

New: [row 114 - Glass per g] Data reflects modelling of the Corning process and upstream materials (Cherrington et al. 2016), which provides data on Primary Energy Demand and Global Warming Potential. For all other environmental indicators data has been upscaled by a factor of 3 from the existing glass for lamps [row 55] dataset to account for the specifics of the lens, cover, display and backside glass used in smartphones and tablets.

New: [row 115 – Silicone] Silicone and similar rubber-like materials are used for sealing and more important for keypads of DECT phones and feature phones. As there is no such material yet included in the EcoReport template data from the OEKOBAUDAT database on silicone is used as a very rough proxy (thinkstep 2020): Total use of renewable and non-renewable primary energy resources as primary energy, Hazardous waste disposed and Non-hazardous waste disposed, Global Warming Potential, Acidification, Eutrophication. Where environmental indicators are not available in the OEKOBAUDAT database the Epoxy dataset of the EcoReport has been used as proxy.

New: [row 116 - NdFeB magnet] As magnets play an important role for audio components, cameras, vibration motor and attachment of accessories, a specific dataset for dominating NdFeB magnets has been derived from literature (Jin et al. 2016), including data on Cumulative Energy Demand, Global Warming Potential, Particulate Matter, Acidification. Where environmental indicators are not available in this source the existing ferrite dataset [row 25] has been used as proxy to account for the similarities of the sintering process.

All new datasets introduced for the purpose of this study are listed in Table 52, which is a screenshot from the "Extra Materials" spreadsheet of the EcoReport template. Stated values are per kg or per 1000 cm² (PCBs, displays, semiconductors), even if in "Name material" a different reference unit is mentioned[4].

[4] This is due to the basic set-up of the EcoReport template: Background data is typically stated in kg, but raw data needs to be entered in grams.

Table 52 : Additional datasets specific to the product group mobile phones, smartphones and tablets, per kg or per 1000 cm²

nr	Name material	Recycle %*	Primairy Energy	Electr energy	feedstock	water proces	Water cool	waste haz	waste non	GWP	AD	VOC	POP	Hma	PAH	PM	HMw	EUP
unit	New Materials production phase (category '**Extra**')	%	MJ	MJ	MJ	L	L	g	g	kg CO2 eq.	g SO2 eq.	mg	ng i-Teq	mg Ni eq.	mg Ni eq.	g	mg Hg/20	mg PO4
100	**Flex PCB Ni/Au-Finish 1-layer per c**	**0**	163,70	70,88	-	1.787,50	-	0,00	91,18	7,80	28,33	2,69	-	72,21	-	1,29	3.459,79	45.156,88
101	**Flex PCB Ni/Au-Finish 1-layer, dou**	0	228,43	130,52	-	1.868,75	-	0,00	122,41	10,36	38,32	3,02	-	76,88	-	1,31	4.685,63	45.983,06
102	**FR4 PCB Ni/Au-Finish 4-layers per**	0	345,01	227,96	-	2.087,50	-	0,00	173,34	15,13	51,85	3,72	-	84,51	-	4,41	6.690,93	47.637,17
103	**FR4 PCB Ni/Au-Finish 6-layers per**	0	491,79	354,38	-	2.256,25	-	0,00	239,38	21,05	68,64	4,57	-	93,52	-	5,61	9.279,42	49.596,40
104	**FR4 PCB Ni/Au-Finish 8-layers per**	0	631,82	480,80	-	2.431,25	-	0,00	305,43	26,57	84,28	5,38	-	101,79	-	6,44	11.853,28	51.335,00
105	**FR4 PCB Ni/Au-Finish 10-layers pe**	0	771,85	607,22	-	2.606,25	-	0,00	371,47	32,09	99,92	6,19	-	110,07	-	7,26	14.427,14	53.073,60
106	**FR4 PCB Ni/Au-Finish 12-layers pe**	0	918,64	733,64	-	2.775,00	-	0,00	437,52	38,01	116,71	7,03	-	119,08	-	8,46	17.015,63	55.032,82
107	**FR4 PCB HAL-Finish 1-layer per cm**	0	152,39	72,56	-	343,75	-	0,00	92,04	7,12	21,79	1,68	-	54,94	-	3,33	1.730,83	3.787,96
108	**FR4 PCB HAL-Finish 1-layer, double**	0	217,12	132,20	-	425,00	-	0,00	123,28	9,68	31,78	2,01	-	59,60	-	4,05	2.956,67	4.614,14
109	**LCO-Battery (Lithium-Cobalt-Oxid)**	0	267,31	-	-	-	-	-	453,21	22,88	136,38	57,23	-	235,39	-	15,82	1.825,35	18.959,24
110	**NiMH battery (AAA)**	0	230,00	-	-	34,66	55,00	19,60	600,54	19,00	764,00	0,12	2,16	7,66	204,65	35,61	74,23	27.400,00
111	**LCD display, smartphone, per cm²**	0	255,83	245,15	-	93,33	-	91,20	112,68	19,59	64,98	5,09	-	119,05	-	6,50	-	12.211,47
112	**LCD display, tablet, per cm²**	0	213,19	204,29	-	77,78	-	76,00	93,90	16,33	54,15	4,24	-	99,21	-	5,42	-	10.176,22
113	**AMOLED panel per cm²**	0	363,93	245,15	-	93,33	-	91,20	112,68	14,27	64,98	5,09	-	119,05	-	6,50	-	12.211,47
114	**Glass per g**	0	27	21,816419	0	24,725275	0	0,8065028	40,580514	2,45	9,012503	0,0131819	0,2294104	0,5305702	0,000859	0,1925659	0,1186721	1,076105625
115	**Silicone**	0	156,63	24,56	42,64	19,00	384,00	0,00	1.434,00	6,86	14,82	-	-	-	0,12	15,00	0,04	1.860,00
116	**NdFeB magnet**	0	330,00	3,42	0,11	39,33	-	-	2.582,28	27,60	440,00	0,20	39,00	36,00	0,10	124,00	2,00	79,00
117	**IC, SoC per cm² die area**	0	33.764,43	27.050,65	-	22.975,39	27.132,00	42.695,42	52.041,86	3.017,45	56.582,32	658,01	-	84.879,02	-	1.216,30	124.862,73	1.556.788,39
118	**IC, DRAM (50% of SoC) per 1cm² di**	0	16.882,22	13.525,32	-	11.487,69	13.566,00	21.347,71	26.020,93	1.508,72	28.291,16	329,00	-	42.439,51	-	608,15	62.431,37	778.394,19
119	**IC, NAND (60% of SoC) per 1cm² di**	0	20.258,66	16.230,39	-	13.785,23	16.279,20	25.617,25	31.225,12	1.810,47	33.949,39	394,80	-	50.927,41	-	729,78	74.917,64	934.073,03
120	**Generic IC per 1cm² die area**	0	26.730,18	21.415,10	-	18.188,85	21.479,50	33.800,54	41.199,81	2.388,81	44.794,34	520,92	-	67.195,89	-	962,90	98.849,66	1.232.457,47

4. SUBTASK 5.2 – BASE CASE ENVIRONMENTAL IMPACT ASSESSMENT (USING ECOREPORT 2014)

In this section, the EcoReport tool is primarily used to calculate the outputs per environmental indicator and "cradle-to-grave" stages of product life.

4.1. Base Case 1: Smartphone, display 5", low-end price segment

Table 53 provides data on material category totals and environmental impacts per product over the service lifetime.

The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category "Extra".

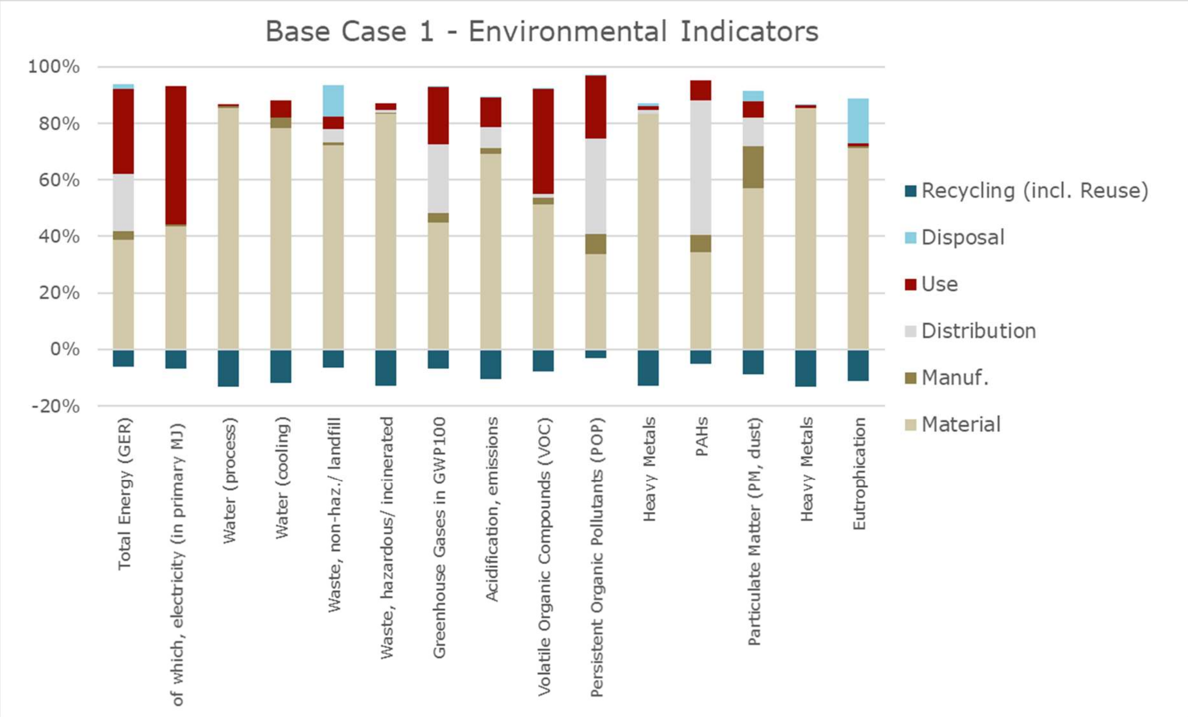
Table 53 : Base Case 1 – Environmental impact assessment, per product

Nr	Life cycle Impact per product:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> / Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**16**		**0**	11	5	0	**0**
2	TecPlastics	g			**58**		**1**	41	17	0	**0**
3	Ferro	g			**18**		**0**	13	5	0	**0**
4	Non-ferro	g			**25**		**0**	17	7	0	**0**
5	Coating	mg			7		0	5	2	0	0
6	Electronics	g			**116**		**1**	82	35	0	**0**
7	Misc.	g			**208**		**2**	0	210	0	**0**
8	Extra	n.a.			231		0	163	70	0	-2
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**440**	**0**	**4**	**164**	**280**	**0**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	217,0	18,4	**235,4**	**112,8**	**168,8**	10,1	-34,2		**492,8**
12	of which, electricity (in primary MJ)	MJ	149,3	2,4	**151,8**	**0,0**	**168,1**	0,0	-23,1		**296,8**
13	Water (process)	ltr	287,4	1,4	**288,8**	**0,0**	**2,9**	0,0	-44,4		**247,3**
14	Water (cooling)	ltr	106,9	5,1	**112,0**	**0,0**	**8,5**	0,0	-16,2		**104,3**
15	Waste, non-haz./ landfill	g	1.675,2	25,2	**1.700,3**	**107,2**	**102,6**	263,3	-148,9		**2.024,5**
16	Waste, hazardous/ incinerated	g	155,4	0,5	**155,8**	**2,1**	**4,2**	0,0	-24,1		**138,1**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	16,0	1,2	**17,2**	**8,7**	**7,3**	0,1	-2,5		**30,8**
18	Acidification, emissions	g SO2 eq.	227,5	6,5	**234,0**	**25,5**	**33,7**	1,5	-34,7		**260,1**
19	Volatile Organic Compounds (VOC)	g	5,2	0,2	**5,5**	**0,1**	**3,8**	0,0	-0,8		**8,5**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,6	0,1	**0,7**	**0,6**	**0,4**	0,0	-0,1		**1,7**
21	Heavy Metals	mg Ni eq.	324,9	0,4	**325,3**	**5,5**	**4,9**	4,5	-50,0		**290,3**
22	PAHs	mg Ni eq.	2,0	0,3	**2,3**	**2,7**	**0,4**	0,0	-0,3		**5,2**
23	Particulate Matter (PM, dust)	g	7,2	1,9	**9,1**	**1,3**	**0,7**	0,4	-1,1		**10,5**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	1.306,0	0,0	**1.306,0**	**0,2**	**13,8**	5,2	-202,2		**1.123,0**
25	Eutrophication	g PO4	11,6	0,1	**11,7**	**0,0**	**0,1**	2,6	-1,8		**12,6**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 1: Base Case 1 - Relative contribution of the life cycle stages based on the EcoReport LCA results



Life cycle impacts are dominated across all environmental indicators by the production phase. Note, that "Material" in the EcoReport covers also complex parts, such as printed circuit boards and semiconductors and should not be interpreted as "raw materials" only. The recycling credits are not actually driven by post-consumer material recycling, but by the high rate of devices being reused outside the EU27 and being accounted here as environmental credits. The use phase is of moderate relative impact, except for total energy, electricity and VOC emissions, where the use phase turns out to be of high relevancy. The distribution phase is of moderate relevancy. Production impacts are dominated by semiconductors, printed circuit boards and displays, all modelled with the newly introduced datasets documented in 3.8. The production impacts of the handset are much higher than those of the power adapter, headset, USB cable and packaging combined. For Base Case 1 this correlation is shown exemplarily in Figure 2.

Figure 2: Base Case 1 – production phase, split of environmental indicators

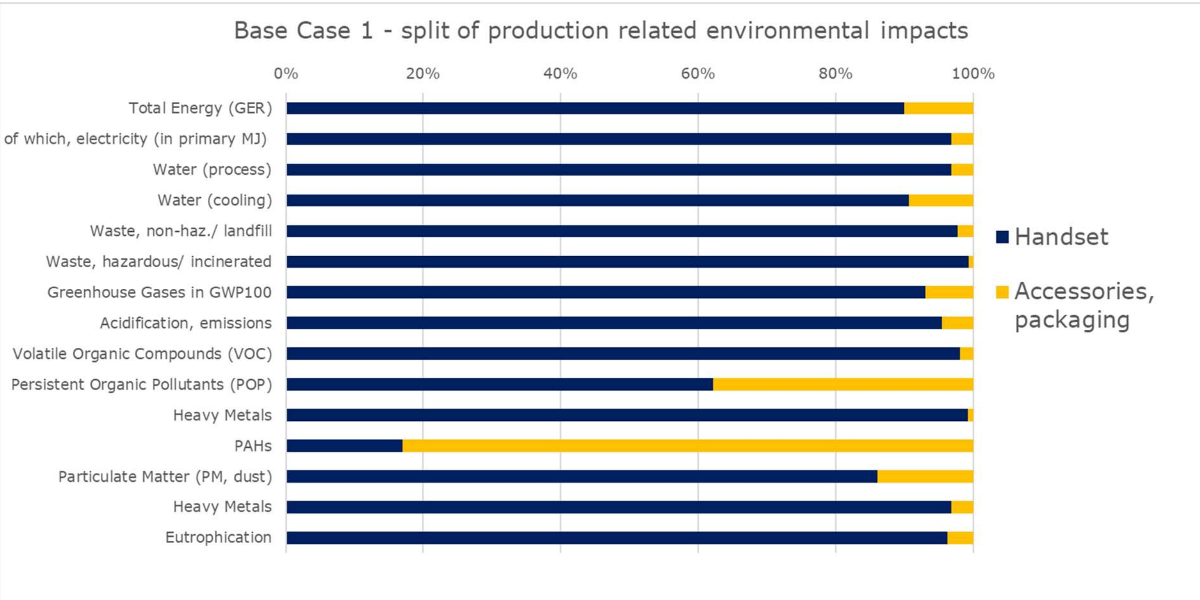


Table 54 list the same assessment as in the table before, but now referring to the functional unit of one year of use of the smartphone.

Table 54 : Base Case 1 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**6**		**0**	5	2	0	**0**
2	TecPlastics	g			**23**		**0**	16	7	0	**0**
3	Ferro	g			**7**		**0**	5	2	0	**0**
4	Non-ferro	g			**10**		**0**	7	3	0	**0**
5	Coating	g			**3**		**0**	2	1	0	**0**
6	Electronics	g			**46**		**0**	33	14	0	**0**
7	Misc.	g			**83**		**1**	0	84	0	**0**
8	Extra	n.a.			92		0	65	28	0	-1
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**176**		**2**	66	112	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	86,8	7,4	**94,2**	**45,1**	**67,5**	4,0	-13,7		**197,1**
12	of which, electricity (in primary MJ)	MJ	59,7	1,0	**60,7**	**0,0**	**67,2**	0,0	-9,2		**118,7**
13	Water (process)	ltr	115,0	0,6	**115,5**	**0,0**	**1,1**	0,0	-17,8		**98,9**
14	Water (cooling)	ltr	42,7	2,1	44,8	0,0	3,4	0,0	-6,5		**41,7**
15	Waste, non-haz./ landfill	g	670,1	10,1	**680,1**	**42,9**	**41,0**	105,3	-59,6		**809,8**
16	Waste, hazardous/ incinerated	g	62,1	0,2	**62,3**	**0,9**	**1,7**	0,0	-9,6		**55,2**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	6,4	0,5	**6,9**	**3,5**	**2,9**	0,0	-1,0		**12,3**
18	Acidification, emissions	g SO2 eq.	91,0	2,6	**93,6**	**10,2**	**13,5**	0,6	-13,9		**104,1**
19	Volatile Organic Compounds (VOC)	g	2,1	0,1	**2,2**	**0,0**	**1,5**	0,0	-0,3		**3,4**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,2	0,1	**0,3**	**0,2**	**0,2**	0,0	0,0		**0,7**
21	Heavy Metals	mg Ni eq.	130,0	0,2	**130,1**	**2,2**	**2,0**	1,8	-20,0		**116,1**
22	PAHs	mg Ni eq.	0,8	0,1	**0,9**	**1,1**	**0,2**	0,0	-0,1		**2,1**
23	Particulate Matter (PM, dust)	g	2,9	0,7	**3,6**	**0,5**	**0,3**	0,2	-0,4		**4,2**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	522,4	0,0	**522,4**	**0,1**	**5,5**	2,1	-80,9		**449,2**
25	Eutrophication	g PO4	4,7	0,0	**4,7**	**0,0**	**0,1**	1,0	-0,7		**5,0**

4.2. Base Case 2: Smartphone, display 6", mid-range

Table 55 provides data on material category totals and environmental impacts per product over the service lifetime.

The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category "Extra".

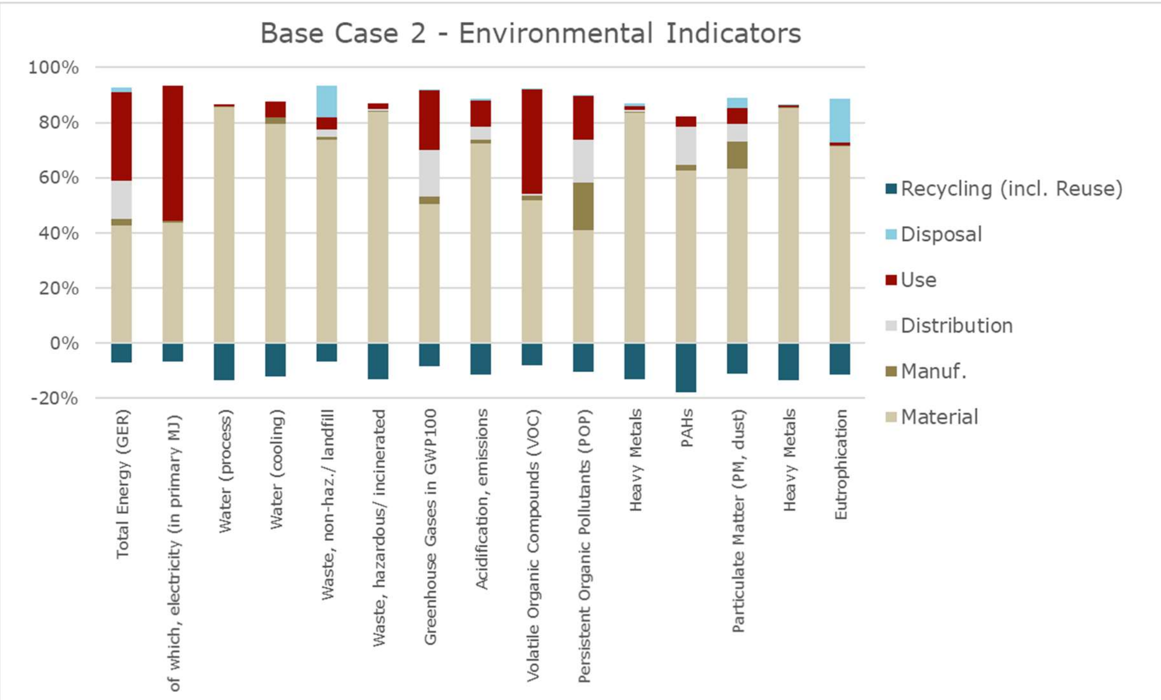
Table 55 : Base Case 2 – Environmental impact assessment, per product

Nr	Life cycle Impact per product:	Reference year	Author
0	Products	2020	Fraunhofer IZM

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**16**		**0**	11	5	0	**0**
2	TecPlastics	g			**43**		**0**	30	13	0	**0**
3	Ferro	g			**18**		**0**	13	5	0	**0**
4	Non-ferro	g			**139**		**1**	46	94	0	**0**
5	Coating	mg			13		0	9	4	0	0
6	Electronics	g			**121**		**1**	86	37	0	**0**
7	Misc.	g			**260**		**3**	0	263	0	**0**
8	Extra	n.a.			288		0	204	87	0	-3
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**597**	**0**	**6**	**186**	**417**	**0**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	349,3	20,6	**369,9**	**112,8**	**261,6**	15,8	-58,6		**701,5**
12	of which, electricity (in primary MJ)	MJ	231,6	3,3	**234,9**	**0,0**	**260,4**	0,0	-35,7		**459,6**
13	Water (process)	ltr	373,4	1,5	**374,9**	**0,0**	**3,7**	0,0	-58,0		**320,6**
14	Water (cooling)	ltr	181,4	5,6	187,0	0,0	13,3	0,0	-27,8		172,5
15	Waste, non-haz./ landfill	g	2.860,2	37,8	**2.898,0**	**107,3**	**161,6**	446,8	-260,3		**3.353,4**
16	Waste, hazardous/ incinerated	g	276,2	0,5	**276,7**	**2,1**	**6,8**	0,0	-42,8		**242,8**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	26,3	1,4	**27,7**	**8,7**	**11,3**	0,1	-4,3		**43,5**
18	Acidification, emissions	g SO2 eq.	397,8	7,2	**405,0**	**25,5**	**52,7**	2,7	-62,9		**422,9**
19	Volatile Organic Compounds (VOC)	g	8,0	0,2	**8,3**	**0,1**	**5,8**	0,0	-1,2		**13,0**
20	Persistent Organic Pollutants (POP)	ng i-Teq	1,6	0,7	**2,3**	**0,6**	**0,6**	0,0	-0,4		**3,1**
21	Heavy Metals	mg Ni eq.	569,0	1,7	**570,6**	**5,5**	**8,3**	8,0	-88,1		**504,3**
22	PAHs	mg Ni eq.	12,4	0,4	**12,7**	**2,7**	**0,7**	0,0	-3,5		**12,7**
23	Particulate Matter (PM, dust)	g	12,7	2,0	**14,7**	**1,3**	**1,2**	0,7	-2,2		**15,7**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	1.686,2	0,0	**1.686,3**	**0,2**	**18,0**	6,7	-262,0		**1.449,1**
25	Eutrophication	g PO4	17,1	0,1	**17,2**	**0,0**	**0,2**	3,8	-2,7		**18,5**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 3: Base Case 2 - Relative contribution of the life cycle stages based on the EcoReport LCA results



Life cycle impacts are dominated across all environmental indicators by the production phase. The recycling credits are not actually driven by post-consumer material recycling, but by the specific post-industrial metal recycling and the high rate of devices being reused outside the EU27 and being accounted here as environmental credits. The use phase is of moderate relative impact, except for total energy, electricity and VOC emissions, where the use phase turns out to be of high relevancy. The distribution phase is of moderate relevancy. Production impacts are dominated by semiconductors and printed circuit boards, all modelled with the newly introduced datasets documented in 3.8. The production impacts of the handset are much higher than those of the power adapter, headset, USB cable and packaging combined.

Table 56 list the same assessment as in the table before, but now referring to the functional unit of one year of use of the smartphone.

Table 56 : Base Case 2 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**5**		**0**	4	2	0	**0**
2	TecPlastics	g			**14**		**0**	10	4	0	**0**
3	Ferro	g			**6**		**0**	4	2	0	**0**
4	Non-ferro	g			**46**		**0**	15	31	0	**0**
5	Coating	mg			4		0	3	1	0	0
6	Electronics	g			**40**		**0**	29	12	0	**0**
7	Misc.	g			**87**		**1**	0	88	0	**0**
8	Extra	n.a.			96		0	68	29	0	-1
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**199**		**2**	62	139	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	116,4	6,9	**123,3**	**37,6**	**87,2**	5,3	-19,5		**233,8**
12	of which, electricity (in primary MJ)	MJ	77,2	1,1	**78,3**	**0,0**	**86,8**	0,0	-11,9		**153,2**
13	Water (process)	ltr	124,5	0,5	**125,0**	**0,0**	**1,2**	0,0	-19,3		**106,9**
14	Water (cooling)	ltr	60,5	1,9	62,3	0,0	4,4	0,0	-9,3		**57,5**
15	Waste, non-haz./ landfill	g	953,4	12,6	**966,0**	**35,8**	**53,9**	148,9	-86,8		**1.117,8**
16	Waste, hazardous/ incinerated	g	92,1	0,2	**92,2**	**0,7**	**2,3**	0,0	-14,3		**80,9**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	8,8	0,5	**9,2**	**2,9**	**3,8**	0,0	-1,4		**14,5**
18	Acidification, emissions	g SO2 eq.	132,6	2,4	**135,0**	**8,5**	**17,6**	0,9	-21,0		**141,0**
19	Volatile Organic Compounds (VOC)	g	2,7	0,1	**2,8**	**0,0**	**1,9**	0,0	-0,4		**4,3**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,5	0,2	**0,8**	**0,2**	**0,2**	0,0	-0,1		**1,0**
21	Heavy Metals	mg Ni eq.	189,7	0,6	**190,2**	**1,8**	**2,8**	2,7	-29,4		**168,1**
22	PAHs	mg Ni eq.	4,1	0,1	**4,2**	**0,9**	**0,2**	0,0	-1,2		**4,2**
23	Particulate Matter (PM, dust)	g	4,2	0,7	**4,9**	**0,4**	**0,4**	0,2	-0,7		**5,2**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	562,1	0,0	**562,1**	**0,1**	**6,0**	2,2	-87,3		**483,0**
25	Eutrophication	g PO4	5,7	0,0	**5,7**	**0,0**	**0,1**	1,3	-0,9		**6,2**

4.3. Base Case 3: Smartphone, display 6,5", high-end

Table 57 provides data on material category totals and environmental impacts per product over the service lifetime.

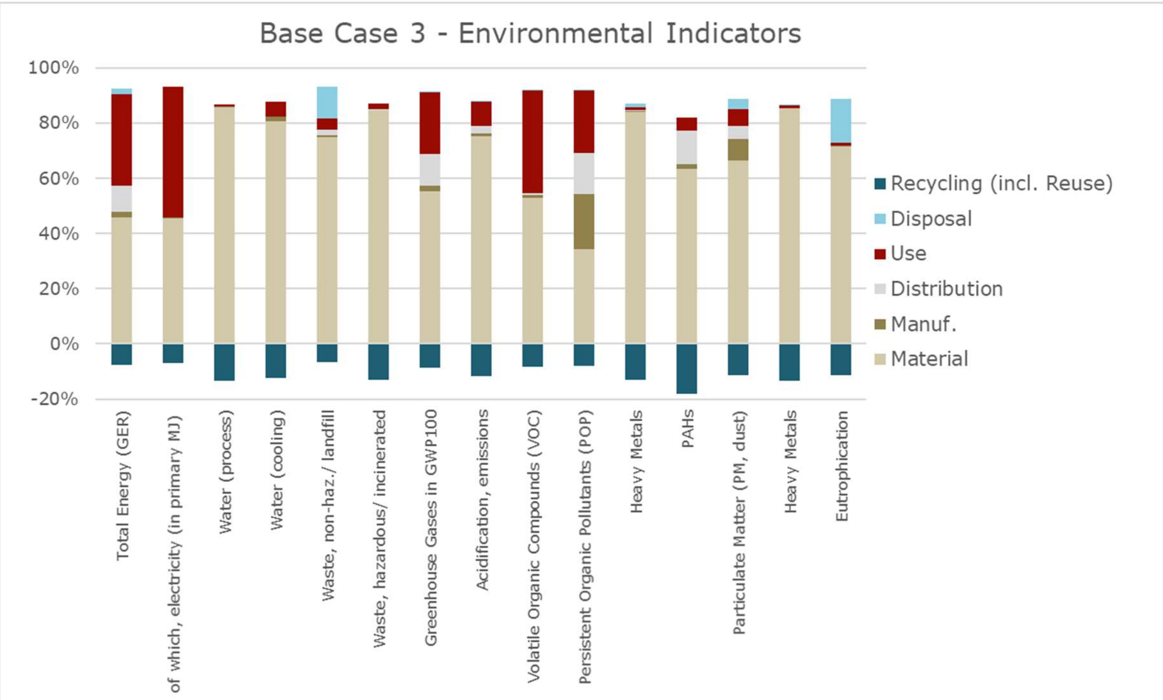
The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category "Extra".

Table 57 : Base Case 3 – Environmental impact assessment, per product

Nr	Life cycle Impact per product:							Reference year	Author		
0	Products							2020	Fraunhofer IZM		
	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**16**		**0**	11	5	0	**0**
2	TecPlastics	g			**49**		**0**	34	15	0	**0**
3	Ferro	g			**16**		**0**	11	5	0	**0**
4	Non-ferro	g			**152**		**2**	51	103	0	**0**
5	Coating	mg			20		0	14	6	0	0
6	Electronics	g			**144**		**1**	101	43	0	**0**
7	Misc.	g			**307**		**3**	0	310	0	**0**
8	Extra	n.a.			342		0	242	104	0	-3
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**683**	**0**	**7**	**209**	**481**	**0**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	541,8	24,2	**566,0**	**113,1**	**390,5**	24,9	-88,9		**1.005,4**
12	of which, electricity (in primary MJ)	MJ	374,7	3,7	**378,4**	**0,0**	**388,8**	0,0	-57,8		**709,4**
13	Water (process)	ltr	508,5	1,8	**510,3**	**0,0**	**5,1**	0,0	-78,7		**436,7**
14	Water (cooling)	ltr	313,1	6,6	319,7	0,0	20,2	0,0	-48,1		291,8
15	Waste, non-haz./ landfill	g	4.503,5	44,0	**4.547,5**	**107,4**	**243,5**	706,0	-406,6		**5.197,8**
16	Waste, hazardous/ incinerated	g	482,7	0,6	**483,2**	**2,1**	**10,9**	0,0	-74,8		**421,5**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	41,8	1,6	**43,4**	**8,7**	**16,9**	0,1	-6,7		**62,5**
18	Acidification, emissions	g SO2 eq.	678,4	8,5	**686,9**	**25,6**	**79,5**	4,5	-106,5		**690,1**
19	Volatile Organic Compounds (VOC)	g	12,3	0,3	**12,6**	**0,1**	**8,7**	0,0	-1,9		**19,6**
20	Persistent Organic Pollutants (POP)	ng i-Teq	1,4	0,8	**2,2**	**0,6**	**0,9**	0,0	-0,3		**3,4**
21	Heavy Metals	mg Ni eq.	984,7	2,0	**986,7**	**5,5**	**13,7**	13,8	-152,4		**867,2**
22	PAHs	mg Ni eq.	14,3	0,4	**14,7**	**2,7**	**1,0**	0,0	-4,1		**14,4**
23	Particulate Matter (PM, dust)	g	19,5	2,4	**21,9**	**1,4**	**1,7**	1,1	-3,3		**22,8**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	2.531,2	0,1	**2.531,3**	**0,2**	**27,0**	10,0	-393,1		**2.175,4**
25	Eutrophication	g PO4	25,5	0,1	**25,6**	**0,0**	**0,3**	5,7	-4,0		**27,7**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 4: Base Case 3 - Relative contribution of the life cycle stages based on the EcoReport LCA results



Life cycle impacts are dominated across all environmental indicators by the production phase. Note, that "Material" in the EcoReport covers also complex parts, such as printed circuit boards and semiconductors and should not be interpreted as "raw materials" only.

The recycling credits are not actually driven by post-consumer material recycling, but by the specific post-industrial metal recycling and the high rate of devices being reused outside the EU27 and being accounted here as environmental credits. The use phase is of moderate relative impact, except for total energy, electricity, Global Warming Potential and VOC emissions, where the use phase turns out to be of high relevancy. The distribution phase is of moderate relevancy. Production impacts are dominated by semiconductors, printed circuit boards and displays, all modelled with the newly introduced datasets documented in 3.8. The production impacts of the handset are much higher than those of the power adapter, headset, USB cable and packaging combined.

Table 58 list the same assessment as in the table before, but now referring to the functional unit of one year of use of the smartphone.

Table 58 : Base Case 3 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> Resources Use and Emissions	unit	PRODUCTION Material	Manuf.	Total	DISTRI-BUTION	USE	END-OF-LIFE* Disposal	Recycl.	Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**5**		**0**	3	1	0	**0**
2	TecPlastics	g			**14**		**0**	10	4	0	**0**
3	Ferro	g			**4**		**0**	3	1	0	**0**
4	Non-ferro	g			**44**		**0**	15	30	0	**0**
5	Coating	g			**6**		**0**	4	2	0	**0**
6	Electronics	g			**41**		**0**	29	12	0	**0**
7	Misc.	g			**88**		**1**	0	89	0	**0**
8	Extra	n.a.			98		0	69	30	0	-1
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**195**		**2**	60	138	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	154,8	6,9	**161,7**	**32,3**	**111,6**	7,1	-25,4		**287,3**
12	of which, electricity (in primary MJ)	MJ	107,1	1,1	**108,1**	**0,0**	**111,1**	0,0	-16,5		**202,7**
13	Water (process)	ltr	145,3	0,5	**145,8**	**0,0**	**1,5**	0,0	-22,5		**124,8**
14	Water (cooling)	ltr	89,5	1,9	91,3	0,0	5,8	0,0	-13,8		**83,4**
15	Waste, non-haz./ landfill	g	1.286,7	12,6	**1.299,3**	**30,7**	**69,6**	201,7	-116,2		**1.485,1**
16	Waste, hazardous/ incinerated	g	137,9	0,2	**138,1**	**0,6**	**3,1**	0,0	-21,4		**120,4**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	11,9	0,5	**12,4**	**2,5**	**4,8**	0,0	-1,9		**17,8**
18	Acidification, emissions	g SO2 eq.	193,8	2,4	**196,3**	**7,3**	**22,7**	1,3	-30,4		**197,2**
19	Volatile Organic Compounds (VOC)	g	3,5	0,1	**3,6**	**0,0**	**2,5**	0,0	-0,5		**5,6**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,4	0,2	**0,6**	**0,2**	**0,3**	0,0	-0,1		**1,0**
21	Heavy Metals	mg Ni eq.	281,3	0,6	**281,9**	**1,6**	**3,9**	3,9	-43,6		**247,8**
22	PAHs	mg Ni eq.	4,1	0,1	**4,2**	**0,8**	**0,3**	0,0	-1,2		**4,1**
23	Particulate Matter (PM, dust)	g	5,6	0,7	**6,2**	**0,4**	**0,5**	0,3	-0,9		**6,5**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	723,2	0,0	**723,2**	**0,0**	**7,7**	2,9	-112,3		**621,5**
25	Eutrophication	g PO4	7,3	0,0	**7,3**	**0,0**	**0,1**	1,6	-1,1		**7,9**

4.4. Base Case 4: Feature Phone

Table 59 provides data on material category totals and environmental impacts per product over the service lifetime.

The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category “Extra”.

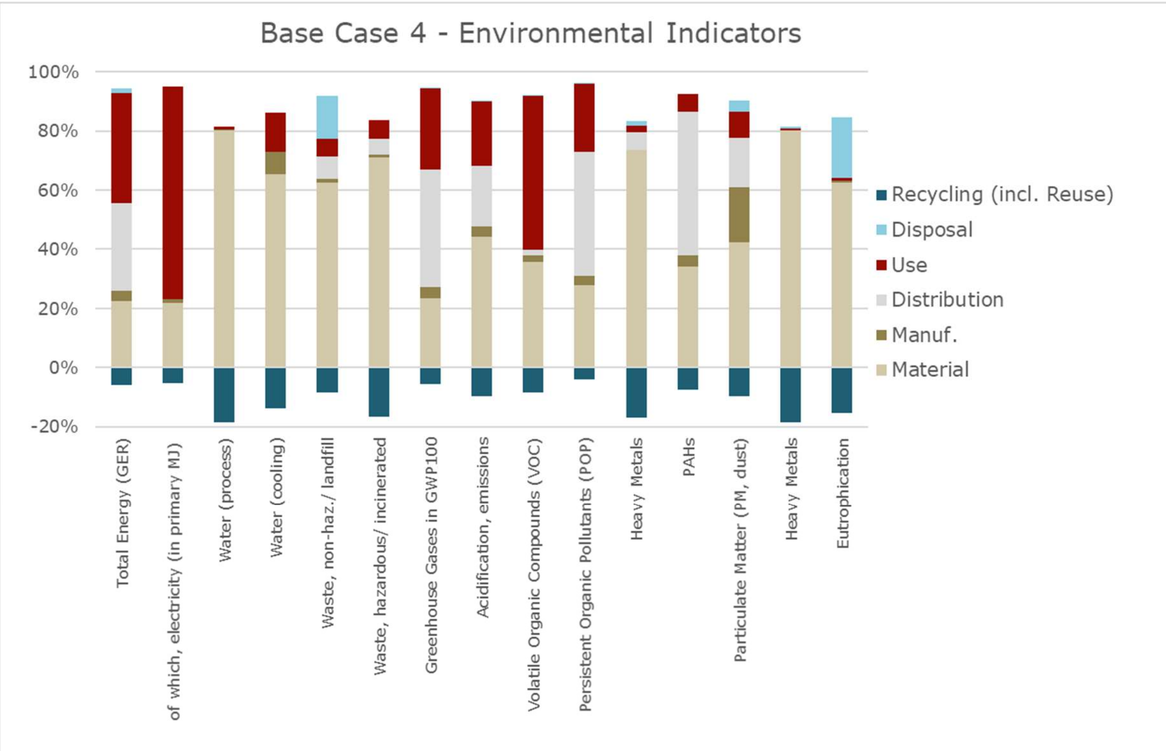
Table 59 : Base Case 4 – Environmental impact assessment, per product

Nr	Life cycle Impact per product:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> / Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**21**		**0**	22	10	-11	**0**
2	TecPlastics	g			**57**		**1**	60	26	-29	**0**
3	Ferro	g			**7**		**0**	7	3	-3	**0**
4	Non-ferro	g			**21**		**0**	22	10	-11	**0**
5	Coating	mg			4		0	4	2	-2	0
6	Electronics	g			**74**		**1**	79	34	-37	**0**
7	Misc.	g			**291**		**3**	0	441	-147	**0**
8	Extra	n.a.			140		0	149	64	-71	-1
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**470**	**0**	**5**	**190**	**522**	**-238**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	85,8	12,8	**98,7**	**112,2**	**140,7**	5,5	-21,9		**335,2**
12	of which, electricity (in primary MJ)	MJ	42,6	2,2	**44,9**	**0,0**	**140,3**	0,0	-10,0		**175,2**
13	Water (process)	ltr	179,3	0,9	**180,2**	**0,0**	**1,8**	0,0	-41,6		**140,4**
14	Water (cooling)	ltr	31,8	3,6	35,4	0,0	6,5	0,0	-6,7		35,2
15	Waste, non-haz./ landfill	g	875,1	19,1	**894,2**	**107,0**	**80,8**	203,9	-116,1		**1.169,8**
16	Waste, hazardous/ incinerated	g	28,1	0,3	**28,4**	**2,1**	**2,5**	0,0	-6,5		**26,5**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	5,1	0,9	**6,0**	**8,7**	**6,0**	0,0	-1,2		**19,5**
18	Acidification, emissions	g SO2 eq.	54,8	4,4	**59,2**	**25,4**	**27,0**	0,6	-12,1		**100,0**
19	Volatile Organic Compounds (VOC)	g	2,2	0,1	**2,3**	**0,1**	**3,1**	0,0	-0,5		**5,1**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,4	0,0	**0,4**	**0,6**	**0,3**	0,0	-0,1		**1,3**
21	Heavy Metals	mg Ni eq.	68,3	0,2	**68,4**	**5,5**	**2,1**	1,4	-15,6		**61,9**
22	PAHs	mg Ni eq.	1,9	0,2	**2,2**	**2,7**	**0,3**	0,0	-0,4		**4,8**
23	Particulate Matter (PM, dust)	g	2,8	1,2	**4,0**	**1,1**	**0,6**	0,3	-0,6		**5,3**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	629,8	0,0	**629,8**	**0,2**	**6,9**	3,8	-146,2		**494,4**
25	Eutrophication	g PO4	5,7	0,1	**5,7**	**0,0**	**0,1**	1,8	-1,4		**6,3**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 5: Base Case 4 - Relative contribution of the life cycle stages based on the EcoReport LCA results



Other than with the smartphones the life cycle impacts of the feature phone base case are not dominated across all environmental indicators by the production phase. Instead, the results for the indicators Total Energy, electricity, and VOC emissions see the use phase as the most important life cycle stage. For Global Warming Potential, POP and PAH emissions to air the distribution phase is the top contributor. The recycling credits are not actually driven by post-consumer material recycling, but by the high rate of devices being reused outside the EU27 and being accounted here as environmental credits. The distribution phase is of moderate relevancy. Production impacts are dominated by semiconductors, and printed circuit boards, all modelled with the newly introduced datasets documented in 3.8. The production impacts of the handset are higher than those of the power adapter, headset, USB cable and packaging combined, but all the latter have significantly higher share than for the smartphone base cases, which is a result of the significantly smaller impact of the handset production.

Table 60 lists the same assessment as in the table before, but now referring to the functional unit of one year of use of the feature phone.

Table 60 : Base Case 4 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> / Resources Use and Emissions	unit	PRODUCTION Material	Manuf.	Total	DISTRI-BUTION	USE	END-OF-LIFE* Disposal	Recycl.	Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**7**		**0**	7	3	-4	**0**
2	TecPlastics	g			**19**		**0**	20	9	-10	**0**
3	Ferro	g			**2**		**0**	2	1	-1	**0**
4	Non-ferro	g			**7**		**0**	7	3	-4	**0**
5	Coating	g			**1**		**0**	1	1	-1	**0**
6	Electronics	g			**25**		**0**	26	11	-12	**0**
7	Misc.	g			**97**		**1**	0	147	-49	**0**
8	Extra	n.a.			47		0	50	21	-24	0
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**157**		**2**	63	174	-79	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	28,6	4,3	**32,9**	**37,4**	**46,9**	1,8	-7,3		**111,7**
12	of which, electricity (in primary MJ)	MJ	14,2	0,7	**15,0**	**0,0**	**46,8**	0,0	-3,3		**58,4**
13	Water (process)	ltr	59,8	0,3	**60,1**	**0,0**	**0,6**	0,0	-13,9		**46,8**
14	Water (cooling)	ltr	10,6	1,2	11,8	0,0	2,2	0,0	-2,2		**11,7**
15	Waste, non-haz./ landfill	g	291,7	6,4	**298,1**	**35,7**	**26,9**	68,0	-38,7		**389,9**
16	Waste, hazardous/ incinerated	g	9,4	0,1	**9,5**	**0,7**	**0,8**	0,0	-2,2		**8,8**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	1,7	0,3	**2,0**	**2,9**	**2,0**	0,0	-0,4		**6,5**
18	Acidification, emissions	g SO2 eq.	18,3	1,5	**19,7**	**8,5**	**9,0**	0,2	-4,0		**33,3**
19	Volatile Organic Compounds (VOC)	g	0,7	0,0	**0,8**	**0,0**	**1,0**	0,0	-0,2		**1,7**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,1	0,0	**0,1**	**0,2**	**0,1**	0,0	0,0		**0,4**
21	Heavy Metals	mg Ni eq.	22,8	0,1	**22,8**	**1,8**	**0,7**	0,5	-5,2		**20,6**
22	PAHs	mg Ni eq.	0,6	0,1	**0,7**	**0,9**	**0,1**	0,0	-0,1		**1,6**
23	Particulate Matter (PM, dust)	g	0,9	0,4	**1,3**	**0,4**	**0,2**	0,1	-0,2		**1,8**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	209,9	0,0	**209,9**	**0,1**	**2,3**	1,3	-48,7		**164,8**
25	Eutrophication	g PO4	1,9	0,0	**1,9**	**0,0**	**0,0**	0,6	-0,5		**2,1**

4.5. Base Case 5: DECT cordless landline phone, with charging cradle / base station

Table 61 provides data on material category totals and environmental impacts per product over the service lifetime.

The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category “Extra”.

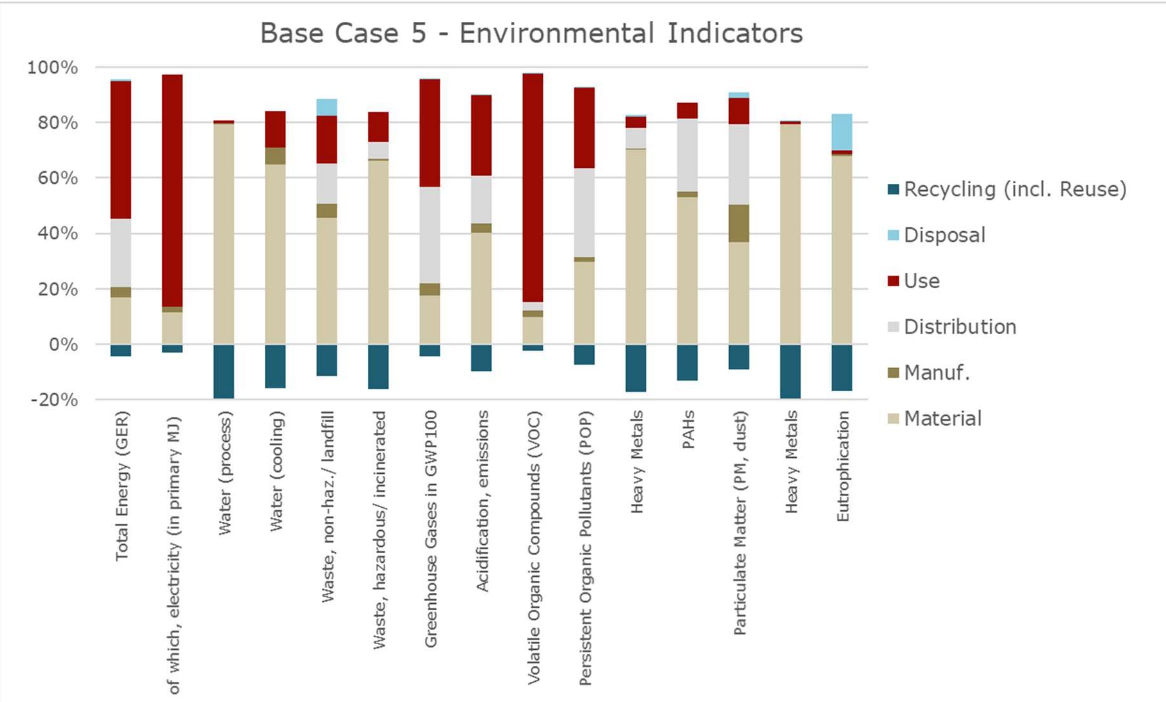
Table 61 : Base Case 5 – Environmental impact assessment, per product

Nr	Life cycle Impact per product:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> / Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE Disposal	END-OF-LIFE Recycl.	END-OF-LIFE Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	g			**169**		**2**	104	104	-38	**0**
2	TecPlastics	g			**49**		**0**	30	30	-11	**0**
3	Ferro	g			**8**		**0**	5	5	-2	**0**
4	Non-ferro	g			**24**		**0**	15	15	-5	**0**
5	Coating	mg			1		0	1	1	0	0
6	Electronics	g			**74**		**1**	45	45	-17	**0**
7	Misc.	g			**122**		**1**	0	150	-28	**0**
8	Extra	n.a.			150		0	93	93	-34	-2
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**444**	**0**	**4**	**200**	**350**	**-101**	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	80,8	18,4	**99,2**	**118,4**	**240,2**	3,2	-20,6		**440,5**
12	of which, electricity (in primary MJ)	MJ	32,9	5,6	**38,6**	**0,0**	**239,7**	0,0	-8,1		**270,2**
13	Water (process)	ltr	155,1	1,0	**156,1**	**0,0**	**1,6**	0,0	-38,0		**119,6**
14	Water (cooling)	ltr	55,9	5,2	**61,1**	**0,0**	**11,2**	0,0	-13,7		**58,6**
15	Waste, non-haz./ landfill	g	339,7	36,5	**376,2**	**109,9**	**126,8**	46,1	-84,6		**574,4**
16	Waste, hazardous/ incinerated	g	24,4	0,3	**24,7**	**2,2**	**4,0**	0,0	-6,0		**24,9**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	4,6	1,2	**5,8**	**9,1**	**10,3**	0,0	-1,1		**24,1**
18	Acidification, emissions	g SO2 eq.	63,2	5,8	**69,0**	**26,9**	**45,8**	0,4	-15,5		**126,6**
19	Volatile Organic Compounds (VOC)	g	0,6	0,1	**0,8**	**0,2**	**5,4**	0,0	-0,2		**6,2**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,6	0,0	**0,6**	**0,6**	**0,6**	0,0	-0,1		**1,7**
21	Heavy Metals	mg Ni eq.	52,4	0,1	**52,5**	**5,6**	**2,9**	0,6	-12,8		**48,9**
22	PAHs	mg Ni eq.	5,8	0,2	**6,0**	**2,8**	**0,6**	0,0	-1,4		**8,0**
23	Particulate Matter (PM, dust)	g	3,9	1,4	**5,4**	**3,1**	**1,0**	0,2	-1,0		**8,7**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	421,4	0,0	**421,4**	**0,2**	**5,2**	1,5	-103,2		**325,1**
25	Eutrophication	g PO4	5,1	0,1	**5,1**	**0,0**	**0,1**	1,0	-1,3		**4,9**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 6: Base Case 5 - Relative contribution of the life cycle stages based on the EcoReport LCA results



The life cycle impacts of the cordless phone base case are not dominated across all environmental indicators by the production phase. Instead, the results for the indicators Total Energy, electricity, Global Warming Potential and VOC emissions see the use phase as the most important life cycle stage. For POP emissions to air the distribution phase is the top contributor. Reuse outside the EU is not relevant for this base case and end of life credits result from post-consumer recycling of e.g. packages and the overall higher recycling rates of devices compared to all other Base Cases.

Production impacts are dominated by semiconductors and printed circuit boards of both, the handset and the base station, all modelled with the newly introduced datasets documented in 3.8. Also the larger plastics parts of the handset and the base station contribute significantly to production related impacts. The production impacts of the handset are higher than those of the power adapter, base station and packaging combined, but all the latter have jointly an production related impact of 40% to 60% for the handset, taking the Global Warming Potential as an example .

Table 62 list the same assessment as in the table before, but now referring to the functional unit of one year of use of the cordless phone and base station.

Table 62 : Base Case 5 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**34**		**0**	21	21	-8	**0**
2	TecPlastics	g			**10**		**0**	6	6	-2	**0**
3	Ferro	g			**2**		**0**	1	1	0	**0**
4	Non-ferro	g			**5**		**0**	3	3	-1	**0**
5	Coating	mg			0		0	0	0	0	0
6	Electronics	g			**15**		**0**	9	9	-3	**0**
7	Misc.	g			**24**		**0**	0	30	-6	**0**
8	Extra	n.a.			30		0	19	19	-7	0
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**89**		**1**	40	70	-20	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	16,2	3,7	**19,8**	**23,7**	**48,0**	0,6	-4,1		**88,1**
12	of which, electricity (in primary MJ)	MJ	6,6	1,1	**7,7**	**0,0**	**47,9**	0,0	-1,6		**54,0**
13	Water (process)	ltr	31,0	0,2	**31,2**	**0,0**	**0,3**	0,0	-7,6		**23,9**
14	Water (cooling)	ltr	11,2	1,0	12,2	0,0	2,2	0,0	-2,7		**11,7**
15	Waste, non-haz./ landfill	g	67,9	7,3	**75,2**	**22,0**	**25,4**	9,2	-16,9		**114,9**
16	Waste, hazardous/ incinerated	g	4,9	0,1	**4,9**	**0,4**	**0,8**	0,0	-1,2		**5,0**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	0,9	0,2	**1,2**	**1,8**	**2,1**	0,0	-0,2		**4,8**
18	Acidification, emissions	g SO2 eq.	12,6	1,2	**13,8**	**5,4**	**9,2**	0,1	-3,1		**25,3**
19	Volatile Organic Compounds (VOC)	g	0,1	0,0	**0,2**	**0,0**	**1,1**	0,0	0,0		**1,2**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,1	0,0	**0,1**	**0,1**	**0,1**	0,0	0,0		**0,3**
21	Heavy Metals	mg Ni eq.	10,5	0,0	**10,5**	**1,1**	**0,6**	0,1	-2,6		**9,8**
22	PAHs	mg Ni eq.	1,2	0,0	**1,2**	**0,6**	**0,1**	0,0	-0,3		**1,6**
23	Particulate Matter (PM, dust)	g	0,8	0,3	**1,1**	**0,6**	**0,2**	0,0	-0,2		**1,7**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	84,3	0,0	**84,3**	**0,0**	**1,0**	0,3	-20,6		**65,0**
25	Eutrophication	g PO4	1,0	0,0	**1,0**	**0,0**	**0,0**	0,2	-0,3		**1,0**

4.6. Base Case 6: Tablet (no attached keyboard)

Table 63 provides data on material category totals and environmental impacts per product over the service lifetime.

The EcoReport material totals table has been adapted by the study authors to avoid double counting due to area based scaling of some entries under the category "Extra".

Table 63 : Base Case 6 – Environmental impact assessment, per product

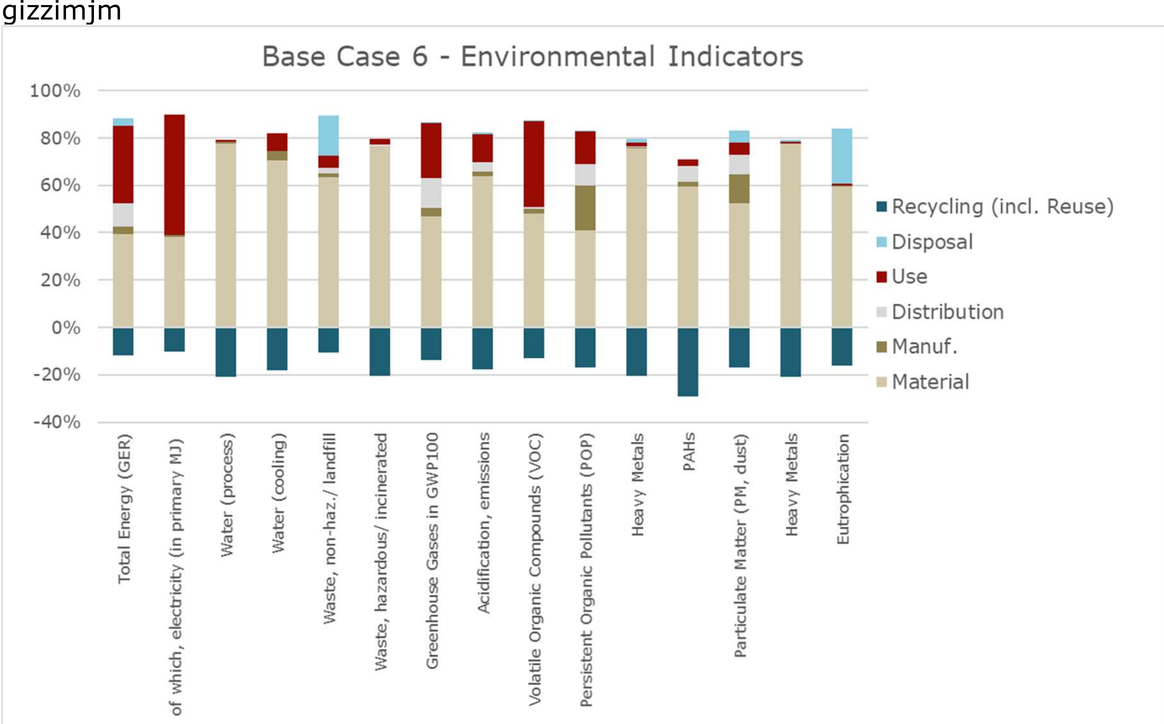
Nr	Life cycle Impact per product:	Reference year	Author
0	Products	2020	Fraunhofer IZM

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**49**		**0**	60	26	-37	**0**
2	TecPlastics	g			**74**		**1**	91	39	-55	**0**
3	Ferro	g			**21**		**0**	26	11	-16	**0**
4	Non-ferro	g			**258**		**3**	149	304	-193	**-1**
5	Coating	mg			13		0	17	7	-10	0
6	Electronics	g			**239**		**2**	294	126	-179	**0**
7	Misc.	g			**685**		**7**	0	1.204	-512	**0**
8	Extra	n.a.			735		0	905	388	-550	-7
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**1.325**	**0**	**13**	**620**	**1.710**	**-991**	**-1**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	477,5	40,7	**518,3**	**117,5**	**398,8**	36,3	-145,0		**925,9**
12	of which, electricity (in primary MJ)	MJ	300,0	6,6	**306,6**	**0,0**	**397,0**	0,0	-80,6		**623,1**
13	Water (process)	ltr	550,6	2,9	**553,6**	**0,0**	**5,5**	0,0	-148,8		**410,3**
14	Water (cooling)	ltr	188,1	11,1	199,1	0,0	19,4	0,0	-48,5		170,0
15	Waste, non-haz./ landfill	g	2.962,9	74,3	**3.037,2**	**109,5**	**232,7**	795,0	-501,1		**3.673,3**
16	Waste, hazardous/ incinerated	g	288,0	1,0	**288,9**	**2,2**	**9,1**	0,0	-77,6		**222,6**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	34,5	2,7	**37,3**	**9,1**	**17,2**	0,2	-10,0		**53,7**
18	Acidification, emissions	g SO2 eq.	425,6	14,2	**439,9**	**26,7**	**78,7**	4,9	-118,9		**431,3**
19	Volatile Organic Compounds (VOC)	g	11,9	0,5	**12,4**	**0,2**	**8,9**	0,0	-3,2		**18,3**
20	Persistent Organic Pollutants (POP)	ng i-Teq	2,8	1,3	**4,1**	**0,6**	**0,9**	0,0	-1,2		**4,5**
21	Heavy Metals	mg Ni eq.	599,3	3,2	**602,5**	**5,6**	**10,0**	14,6	-161,4		**471,3**
22	PAHs	mg Ni eq.	25,1	0,7	**25,8**	**2,8**	**1,2**	0,0	-12,3		**17,5**
23	Particulate Matter (PM, dust)	g	17,5	4,0	**21,4**	**2,8**	**1,8**	1,7	-5,6		**22,0**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	2.325,5	0,1	**2.325,6**	**0,2**	**25,0**	16,1	-629,5		**1.737,3**
25	Eutrophication	g PO4	23,8	0,2	**24,0**	**0,0**	**0,3**	9,3	-6,5		**27,1**

The relative contribution of the life cycle stages per environmental indicator is shown in the following bar chart.

Figure 7: Base Case 6 - Relative contribution of the life cycle stages based on the EcoReport LCA results

gizzimjm



Life cycle impacts are dominated across all environmental indicators by the production phase, except for electricity, where the use phase is more dominant. The recycling credits are not actually driven by post-consumer material recycling, but by the specific post-industrial metal recycling and the high rate of devices being reused outside the EU27 and being accounted here as environmental credits. The distribution phase is of moderate relevancy. Production impacts are dominated by semiconductors, printed circuit boards and displays, followed by the battery, all modelled with the newly introduced datasets documented in 3.8. The production impacts of the tablet are more than a magnitude higher than those of the power adapter, headset, USB cable and packaging combined.

Table 64 list the same assessment as in the table before, but now referring to the functional unit of one year of use of the tablet.

Table 64 : Base Case 6 – Environmental impact assessment, per year of use

Nr	Life cycle Impact per product per year of use:	Reference year	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	g			**10**		**0**	12	5	-7	**0**
2	TecPlastics	g			**15**		**0**	18	8	-11	**0**
3	Ferro	g			**4**		**0**	5	2	-3	**0**
4	Non-ferro	g			**52**		**1**	30	61	-39	**0**
5	Coating	mg			3		0	3	1	-2	0
6	Electronics	g			**48**		**0**	59	25	-36	**0**
7	Misc.	g			**137**		**1**	0	241	-102	**0**
8	Extra	n.a.			147		0	181	78	-110	-1
9	Auxiliaries	g			**0**		**0**	0	0	0	**0**
10	Refrigerant	g			**0**		**0**	0	0	0	**0**
	Total weight	g			**265**		**3**	124	342	-198	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	MJ	95,5	8,1	**103,7**	**23,5**	**79,8**	7,3	-29,0		**185,2**
12	of which, electricity (in primary MJ)	MJ	60,0	1,3	**61,3**	**0,0**	**79,4**	0,0	-16,1		**124,6**
13	Water (process)	ltr	110,1	0,6	**110,7**	**0,0**	**1,1**	0,0	-29,8		**82,1**
14	Water (cooling)	ltr	37,6	2,2	39,8	0,0	3,9	0,0	-9,7		**34,0**
15	Waste, non-haz./ landfill	g	592,6	14,9	**607,4**	**21,9**	**46,5**	159,0	-100,2		**734,7**
16	Waste, hazardous/ incinerated	g	57,6	0,2	**57,8**	**0,4**	**1,8**	0,0	-15,5		**44,5**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	kg CO2 eq.	6,9	0,5	**7,5**	**1,8**	**3,4**	0,0	-2,0		**10,7**
18	Acidification, emissions	g SO2 eq.	85,1	2,8	**88,0**	**5,3**	**15,7**	1,0	-23,8		**86,3**
19	Volatile Organic Compounds (VOC)	g	2,4	0,1	**2,5**	**0,0**	**1,8**	0,0	-0,6		**3,7**
20	Persistent Organic Pollutants (POP)	ng i-Teq	0,6	0,3	**0,8**	**0,1**	**0,2**	0,0	-0,2		**0,9**
21	Heavy Metals	mg Ni eq.	119,9	0,6	**120,5**	**1,1**	**2,0**	2,9	-32,3		**94,3**
22	PAHs	mg Ni eq.	5,0	0,1	**5,2**	**0,6**	**0,2**	0,0	-2,5		**3,5**
23	Particulate Matter (PM, dust)	g	3,5	0,8	**4,3**	**0,6**	**0,4**	0,3	-1,1		**4,4**
	Emissions (Water)										
24	Heavy Metals	mg Hg/20	465,1	0,0	**465,1**	**0,0**	**5,0**	3,2	-125,9		**347,5**
25	Eutrophication	g PO4	4,8	0,0	**4,8**	**0,0**	**0,1**	1,9	-1,3		**5,4**

4.7. Comparison of Base Cases results and with third party assessments

4.7.1. Environmental assessment

Greenhouse gas emissions per life cycle phase as calculated for the Base Cases is listed below in Table 65 and Figure 8. The results for this environmental indicator can be considered more reliable than for other indicators as numerous of the dataset show gaps in some of the other indicator categories. Greenhouse gas emissions are also among the most researched and used life cycle indicators in general and in the ICT sector in particular, making this a robust metric.

Table 65 : Base Cases overview - Greenhouse gas emissions, per product

	Greenhouse gas emissions per product in CO2-e	Reference year	Author
	Products	2020	Fraunhofer IZM

Life Cycle phases -->	PRODUCTION			DISTRIBUTION	USE	END-OF-LIFE			TOTAL
	Material	Manuf.	Total			Disposal	Recycl.	Stock	
Base Case 1	16,7	1,2	17,9	8,7	7,3	0,1	-2,6	0,0	31,4
Base Case 2	26,3	1,4	27,7	8,7	11,3	0,1	-4,3	0,0	43,5
Base Case 3	41,8	1,6	43,4	8,7	16,9	0,1	-6,7	0,0	62,5
Base Case 4	5,1	0,9	6,0	8,7	6,0	0,0	-1,2	0,0	19,5
Base Case 5	4,6	1,2	5,8	9,1	10,3	0,0	-1,1	0,0	24,1
Base Case 6	34,5	2,7	37,3	9,1	17,2	0,2	-10,0	0,0	53,7

Results for the production phase ranges from 5,8 kg CO_2-e in case of the cordless phone (including inter alia the base station) to 37,3 kg CO_2-e for the tablet base case and 43,4 kg CO_2-e for the high-end smartphone segment.

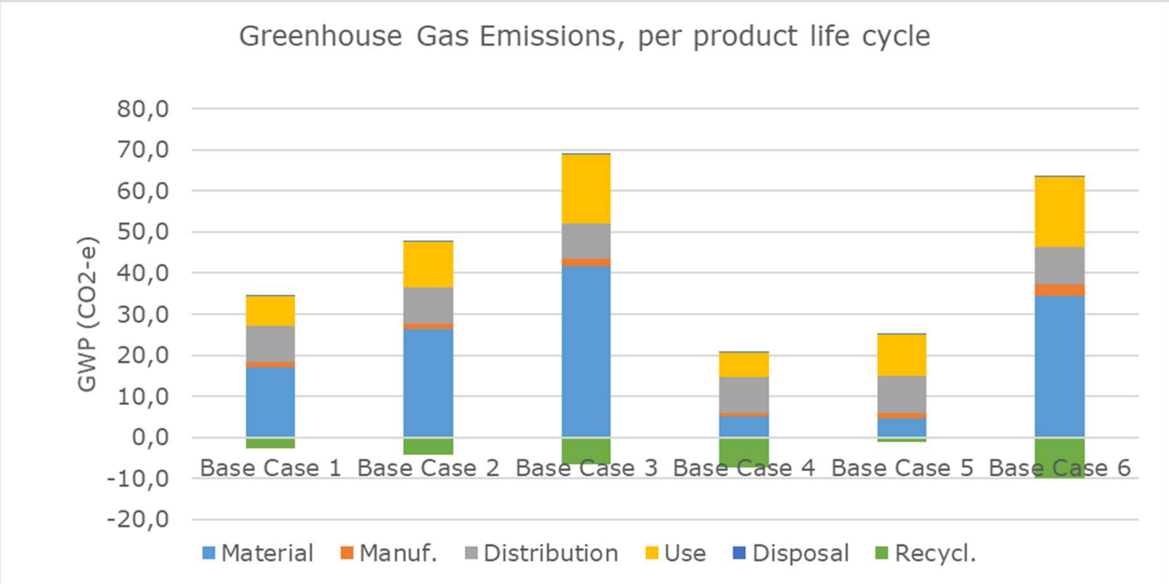


Figure 8 : Base Cases overview - Greenhouse gas emissions, per product

Compared with carbon footprint data published by OEMs for their products the carbon emissions of the production phase of the Base Cases seems to be rather low (Clément et al. 2020): For high-end smartphones production related greenhouse gas emissions up to twice the value found in this study are stated. Mid-range smartphones are in the range of 30 – 40 kg CO_2-e typically, whereas this study – based on the specific new data sets detailed in 3.8 - calculates with 27,7 kg CO_2-e. Use phase carbon emissions for the Base Cases roughly corresponds with industry data and our difference between the low-end and high-end smartphone Base Case is partly due to the differences in lifetimes (2,5 years vs. 3,5 years), whereas industry data frequently refers to a modelled lifetime of 3 years, not distinguishing smartphone classes.

To counter this expected effect updated and more accurate background datasets have been developed for this study (3.8), which moves assessment results in a more plausible range. Still, impacts are likely underestimated for various reasons:

- Standard EcoReport datasets do not represent the specific and high-tech materials used for ICT (such as specialty alloys)
- Specific surface finishing processes are not covered
- Yield rates and losses are not properly covered due to high confidentiality of such data

- Assembly data is based on product weight and does not account for the complexity of mobile phone assembly, nor the required manufacturing environment or product test

Given these considerations, this preparatory study still tends to underestimate production related effects of this product group, which might be roughly in the range of 25% lower impacts.

The distribution phase seems to get too much weight with the MEErP EcoReport approach when being compared with LCAs by OEMs. Results for this specific aspect might be overestimated by a factor of 2 to 3 compared to such environmental declarations (Clément et al. 2020).

The high recycling credits in this study are not mirrored by claims made by OEMs for their products, for very good reasons: Counting post-industrial waste as credit should typically only be done, if detailed insights in the supply chain justify such modelling and this study also calculates with uncontrolled device reuse outside the EU27 as credit. The analysis in Task 4 provides some evidence for this assumption, but uncertainty is high. The rationale to include post-industrial recycling for Base Cases 2, 3 and 6 in the end-of-life scenario is provided in the respective Base Case chapters of subtask 5.1.

Note: The recycling figures in the assessment tool include reuse outside of EU27, which in the tool is allocated as "recycling credit".

4.7.2. Critical Raw Materials assessment

MEErP requires a separate assessment of the critical raw materials content in ErP. Based on the analysis in Task 4 for many CRMs the content in mobile phones, smartphones and tablets can be approximated (Table 66), but it should be kept in mind, that content can vary widely, frequently by one, sometimes two orders of magnitude.

Table 66: All Base Cases - CRM assessment

Critical Raw Material	Weight in g per product				Characterization factor [kg Sb eq./kg]	CRM indicator			
	Base Cases 1-3 (smartphones)	Base Case 4 (feature phone)	Base Case 5 (cordless phone)	Base Case 6 (tablet)		Base Cases 1-3 (smartphones)	Base Case 4 (feature phone)	Base Case 5 (cordless phone)	Base Case 6 (tablet)
Germanium (Ge)					18	0	0	0	0
Beryllium (Be)					12	0	0	0	0
Tantalum (Ta)	0,02	0,09	0,0005	0,04	9	0,00018	0,00081	0,0000045	0,00036
Indium (In)	0,01	0,01		0,02	9	0,00009	0,00009	0	0,00018
Platinum Group metals (PGM)	0,01	0,02	0,02	0,01	8	0,00008	0,00016	0,00016	0,00008
Gallium (Ga)	0,0004	0,005		0,002	8	0,0000032	0,00004	0	0,000016
Antimony (Sb)					1	0	0	0	0
Tungsten					0,2	0	0	0	0
Niobium (Nb)					0,04	0	0	0	0
Rare earth elements (Sc, Y, Nd)	0,1	0,1	0,21	0,75	0,03	0,000003	0,000003	0,0000063	0,0000225
Cobalt (Co)	6	3	0,7	15	0,02	0,00012	0,00006	0,000014	0,0003
Graphite (C)					0,01	0	0	0	0
Fluorspar (CaF2)					0,001	0	0	0	0
Magnesium (Mg)	5,54			20	0,0005	0,00000277	0	0	0,00001
CRM indicator						**0,00047897**	**0,001163**	**0,0001848**	**0,0009685**

Multiplying the specific CRM content with the characterisation factors set by MEErP results in a ranking of CRMs: Tantalum is the most relevant CRM for Base Cases 1 – 4 and 6. Platinum Group Metals (Palladium in this case) seem to be most relevant for cordless phones, but as this data point refers to an analysis of EoL phones this might not correspond with current product technology. We do not have indications that Palladium is used in relevant amounts in cordless phones. Indium in displays and PGM are relevant for smartphones, feature phones and tablets. Gallium is increasingly used in RF components, but the overall CRM indicator is lower than for the aforementioned CRMs. Cobalt in batteries is relevant as well. Magnesium in mid-frames of smartphones and tablets does not contribute significantly to the CRM assessment.

5. SUBTASKS 5.3 AND 5.4 – BASE CASE LIFE CYCLE COST FOR CONSUMER AND SOCIETY

The calculation of the life cycle costs for consumers using the LCC equations available in the MEErP is the given task of this section.

To ease the reading, this section merges subtasks 5.3 and 5.4 of the MEErP and includes also a calculation of the life cycle costs for society as described in the MEErP, following the extended LCC equations with CO_2 stock price, societal damage of certain emissions, etc.

The initial societal costs, i.e. costs of damages to the environment as defined by the MEErP date back to 2011. Scientific progress in the meantime lead to some new cost figures for the various environmental impacts. A recent scientific source is a methodology paper by the German Federal Environmental Agency (Matthey and Bünger 2019). Values are provided for only some of the environmental indicators.

Table 67 : Societal costs according to MEErP 2011 and updated figures based on UBA 2019

Environmental indicator	**unit**	MEErP, 2011	UBA, 2019	
		Rate external marginal costs to society (€/unit)	Environmental damage (€/unit)	Comments
GHG	kg CO2 eq.	0,014	0,187	187 €/t for the year 2020; for a sensitivity analysis even a value of 650 €/t is recommended by the authors
AP	g SO2 eq.	0,0085	0,01504	15.040 €/t SO2, effective in Germany
VOC	g	0,00076	0,00205	2.050 €/t NMVOC, effective in Germany
POP	ng i-Teq	0,000027		
HM1	mg Ni eq.	0,000175		
HM2	mg Ni eq.	0,00004		
HM3	mg Ni eq.	0,0003		
PAH	mg Ni eq.	0,001279		
PM	g	0,01546	0,0412	41.200 €/t PM10, effective in Germany

The analysis below provides an alternative calculation with these updated figures.

5.1. Base Case 1: Smartphone, display 5”, low-end price segment

The Table 68 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net Present Value of the running costs -which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 11,534 billion Euros for this Base Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 68 : Base Case 1 – Life cycle cost for consumer and society

	Item	0	LCC new product		total annual consumer expenditure in EU27	
D	Product price		200	€	10.800	mln.€
E	Installation/ acquisition costs (if any)		0	€	0	mln.€
F	Fuel (gas, oil, wood)		0	€	0	mln.€
F	Electricity		4	€	213	mln.€
G	Water		0	€	0	mln.€
H	Aux. 1: None		0	€	0	mln.€
I	Aux. 2 :None		0	€	0	mln.€
J	Aux. 3: None		0	€	0	mln.€
K	Repair & maintenance costs		10	€	522	mln.€
L	External damages total, of which		4		196	mln.€
	- production PPext	3			153	
	- lifetime operating expense N*OEext	0			22	
	- end-of-life OELext	0			21	
	Total		217	€	11.730	mln.€

Societal costs, i.e. external damage is 4 Euros per product, or 196 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP.

Calculating with more recent societal costs yields a calculated societal damage of 12 Euros per product, or 674 million Euros for all products covered by this Base Case.

Table 69 : Base Case 1 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product		total annual consumer expenditure in EU27	
D	Product price		200	€	10.800	mln.€
E	Installation/ acquisition costs (if any)		0	€	0	mln.€
F	Fuel (gas, oil, wood)		0	€	0	mln.€
F	Electricity		4	€	213	mln.€
G	Water		0	€	0	mln.€
H	Aux. 1: None		0	€	0	mln.€
I	Aux. 2 :None		0	€	0	mln.€
J	Aux. 3: None		0	€	0	mln.€
K	Repair & maintenance costs		10	€	522	mln.€
L	External damages total, of which		12		674	mln.€
	- production PPext	9			510	
	- lifetime operating expense N*OEext	2			103	
	- end-of-life OELext	1			61	
	Total		226	€	12.208	mln.€

5.2. Base Case 2: Smartphone, display 6", mid-range

The Table 70 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net Present Value of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 23,494 billion Euros for this Base

Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 70 : Base Case 2 – Life cycle cost for consumer and society

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		500	€		22.500	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		6	€		274	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		16	€		720	mln.€
L	External damages total, of which		6			264	mln.€
	- production PPext	5			204		
	- lifetime operating expense N*OEext	1			28		
	- end-of-life OELext	1			31		
	Total		528	€		23.758	mln.€

Societal costs, i.e. external damage is 6 Euros per product, or 264 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP

Calculating with more recent societal costs yields a calculated societal damage of 19 Euros per product, or 855 million Euros for all products covered by this Base Case.

Table 71 : Base Case 2 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		500	€		22.500	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		6	€		274	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		16	€		720	mln.€
L	External damages total, of which		19			855	mln.€
	- production PPext	14			634		
	- lifetime operating expense N*OEext	3			133		
	- end-of-life OELext	2			88		
	Total		541	€		24.350	mln.€

5.3. Base Case 3: Smartphone, display 6,5", high-end

Table 72 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net Present Value of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 39,996 billion Euros for this Base Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 72 : Base Case 3 – Life cycle cost for consumer and society

	Item	0	LCC new product			total annual consumer expenditure in EU27
D	Product price		1.000	€		**38.571** mln.€
E	Installation/ acquisition costs (if any)		0	€		**0** mln.€
F	Fuel (gas, oil, wood)		0	€		**0** mln.€
F	Electricity		9	€		**351** mln.€
G	Water		0	€		**0** mln.€
H	Aux. 1: None		0	€		**0** mln.€
I	Aux. 2 :None		0	€		**0** mln.€
J	Aux. 3: None		0	€		**0** mln.€
K	Repair & maintenance costs		28	€		**1.074** mln.€
L	**External damages total, of which**		9			**364** mln.€
	- production PPext	7			**284**	
	- lifetime operating expense N*OEext	1			**37**	
	- end-of-life OELext	1			**44**	
	Total		**1.046**	€		**40.360** mln.€

This Base Case represents the largest annual consumer expenditure of all Base Cases.

Societal costs, i.e. external damage is 9 Euros per product, or 364 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP

Calculating with more recent societal costs yields a calculated societal damage of 29 Euros per product, or 1,128 billion Euros for all products covered by this Base Case.

Table 73 : Base Case 3 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product			total annual consumer expenditure in EU27
D	Product price		1.000	€		**38.571** mln.€
E	Installation/ acquisition costs (if any)		0	€		**0** mln.€
F	Fuel (gas, oil, wood)		0	€		**0** mln.€
F	Electricity		9	€		**351** mln.€
G	Water		0	€		**0** mln.€
H	Aux. 1: None		0	€		**0** mln.€
I	Aux. 2 :None		0	€		**0** mln.€
J	Aux. 3: None		0	€		**0** mln.€
K	Repair & maintenance costs		28	€		**1.074** mln.€
L	**External damages total, of which**		29			**1.128** mln.€
	- production PPext	22			**835**	
	- lifetime operating expense N*OEext	4			**171**	
	- end-of-life OELext	3			**122**	
	Total		**1.066**	€		**41.124** mln.€

5.4. Base Case 4: Feature Phone

Table 74 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net

Present Value of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 1,36 billion Euros for this Base Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 74 : Base Case 4 – Life cycle cost for consumer and society

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		80	€		1.200	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		3	€		62	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		5	€		98	mln.€
L	External damages total, of which		1			24	mln.€
	- production PPext	1			15		
	- lifetime operating expense N*OEext	0			6		
	- end-of-life OELext	0			2		
	Total		90	€		1.384	mln.€

Compared to the other mobile phone Base Cases this one is significantly less relevant in terms of total consumer expenditure.

Societal costs, i.e. external damage is 1 Euro per product, or 15 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP

Calculating with more recent societal costs yields a calculated societal damage of 6 Euros per product, or 100 million Euros for all products covered by this Base Case.

Table 75 : Base Case 4 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		80	€		1.200	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		3	€		62	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		5	€		98	mln.€
L	External damages total, of which		6			100	mln.€
	- production PPext	4			64		
	- lifetime operating expense N*OEext	2			29		
	- end-of-life OELext	0			7		
	Total		95	€		1.460	mln.€

5.5. Base Case 5: DECT cordless landline phone, with charging cradle / base station

Table 76 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net Present Value of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 823 million Euros for this Base Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 76 : Base Case 5 – Life cycle cost for consumer and society

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		50	€		690	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		6	€		82	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		4	€		51	mln.€
L	**External damages total, of which**		2			27	mln.€
	- production PPext	1			16		
	- lifetime operating expense N*OEext	1			8		
	- end-of-life OELext	0			2		
	Total		61	€		849	mln.€

Societal costs, i.e. external damage is 2 Euros per product, or 27 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP

Calculating with more recent societal costs yields a calculated societal damage of 8 Euros per product, or 109 million Euros for all products covered by this Base Case.

Table 77 : Base Case 5 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		50	€		690	mln.€
E	Installation/ acquisition costs (if any)		0	€		0	mln.€
F	Fuel (gas, oil, wood)		0	€		0	mln.€
F	Electricity		6	€		82	mln.€
G	Water		0	€		0	mln.€
H	Aux. 1: None		0	€		0	mln.€
I	Aux. 2 :None		0	€		0	mln.€
J	Aux. 3: None		0	€		0	mln.€
K	Repair & maintenance costs		4	€		51	mln.€
L	**External damages total, of which**		8			109	mln.€
	- production PPext	5			64		
	- lifetime operating expense N*OEext	3			39		
	- end-of-life OELext	1			7		
	Total		67	€		932	mln.€

5.6. Base Case 6: Tablet (no attached keyboard)

Table 78 below gives the Life Cycle Costs for this Base Case, using the rates and prices entered as economic data in Task 5.1. Furthermore, to compare the discounted Net Present Value of the running costs --which is the specific viewpoint of Life Cycle Costing-- with the actual expenditure today, the second column also gives the total consumer expenditure in the EU27 per year, which is 8,664 billion Euros for this Base Case. The purchase price is in average much more a total cost driver than electricity or repair costs, but it should be kept in mind, that this is an average only and individual repair cases are much more relevant for individuals once they are confronted with a defect product.

Table 78 : Base Case 6 – Life cycle cost for consumer and society

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		330	€		**7.887**	mln.€
E	Installation/ acquisition costs (if any)		0	€		**0**	mln.€
F	Fuel (gas, oil, wood)		0	€		**0**	mln.€
F	Electricity		9	€		**280**	mln.€
G	Water		0	€		**0**	mln.€
H	Aux. 1: None		0	€		**0**	mln.€
I	Aux. 2 :None		0	€		**0**	mln.€
J	Aux. 3: None		0	€		**0**	mln.€
K	Repair & maintenance costs		17	€		**497**	mln.€
L	**External damages total, of which**		7			**184**	mln.€
	- production PPext	5			**123**		
	- lifetime operating expense N*OEext	1			**28**		
	- end-of-life OELext	1			**32**		
	Total		**363**	€		**8.848**	mln.€

Societal costs, i.e. external damage is 7 Euros per product, or 184 million Euros for all products covered by this Base Case, according to the societal costs factors defined in the MEErP

Calculating with more recent societal costs yields a calculated societal damage of 25 Euros per product, or 637 million Euros for all products covered by this Base Case.

Table 79 : Base Case 6 – Life cycle cost for consumer and society – Updated societal costs

	Item	0	LCC new product			total annual consumer expenditure in EU27	
D	Product price		330	€		**7.887**	mln.€
E	Installation/ acquisition costs (if any)		0	€		**0**	mln.€
F	Fuel (gas, oil, wood)		0	€		**0**	mln.€
F	Electricity		9	€		**280**	mln.€
G	Water		0	€		**0**	mln.€
H	Aux. 1: None		0	€		**0**	mln.€
I	Aux. 2 :None		0	€		**0**	mln.€
J	Aux. 3: None		0	€		**0**	mln.€
K	Repair & maintenance costs		17	€		**497**	mln.€
L	**External damages total, of which**		25			**637**	mln.€
	- production PPext	17			**403**		
	- lifetime operating expense N*OEext	4			**135**		
	- end-of-life OELext	4			**99**		
	Total		**381**	€		**9.300**	mln.€

5.7. Comparison of Base Cases results

Total Life Cycle Costs across all six Base Cases is 85,7 billion Euros. High-end smartphones (Base Case 3) represent almost 50% of these whereas Life Cycle Costs for feature phones (Base Case 4) and cordless phones (Base Case 5) are a marginal 2% and 1% respectively, but still representing a large number of consumers in EU27 (Table 80).

Total repair related Life Cycle Costs for all new products introduced in the market in 2020 is a forecasted 2,96 billion Euros. The share of electricity costs among the Life Cycle Costs adds up to 1,26 billion Euros.

Total societal costs of the products covered by this study are just above 1 billion Euros, calculated with the MEErP standard values. With the updated societal costs introduced at the beginning of subtasks 5.3 and 5.4 the total societal costs are significantly higher: External environmental damages of this product group according to these figures is in the range of 3,5 billion Euros annually.

Table 80 : Base Cases overview – Life cycle cost for consumer and society

	Item	LCC new product, €, per product						total annual consumer expenditure in EU27 , in mln.€					
		BC 1	BC2	BC3	BC4	BC5	BC6	BC 1	BC2	BC3	BC4	BC5	BC6
D	Product price	200	500	1.000	80	50	330	10.800	22.500	38.571	1.200	690	7.887
E	Installation/ acquisition costs (if any)	0	0	0	0	0	0	0	0	0	0	0	0
F	Fuel (gas, oil, wood)	0	0	0	0	0	0	0	0	0	0	0	0
F	Electricity	4	6	9	3	6	9	213	274	351	62	82	280
G	Water	0	0	0	0	0	0	0	0	0	0	0	0
H	Aux. 1: None	0	0	0	0	0	0	0	0	0	0	0	0
I	Aux. 2 :None	0	0	0	0	0	0	0	0	0	0	0	0
J	Aux. 3: None	0	0	0	0	0	0	0	0	0	0	0	0
K	Repair & maintenance costs	10	16	28	5	4	17	522	720	1.074	98	51	497
	Total	214	522	1.037	89	59	356	**11.534**	**23.494**	**39.996**	**1.360**	**823**	**8.664**
	Share							13%	27%	47%	2%	1%	10%
	Total all Base Cases							85.871					
	Additional societal costs	3,58	5,86	9,44	1,49	1,91	7,45	193	264	364	24	27	184
	Total all Base Cases							1.056					
Updated societal costs:													
	Additional societal costs	12,26	19,01	29,25	6,27	7,78	25,47	662	855	1.128	100	109	637
	Total all Base Cases							3.491					

6. SUBTASK 5.5 – EU TOTALS

This subtask aggregates the results of sections 5.3 and 5.4 (per product) to calculate EU total impacts and costs.

As the data model does not include the hibernation phase the end-of-life figures in the following tables include all those devices entering the hibernation phase in 2020, but being actually disposed later on.

6.1. Base Case 1: Smartphone, display 5", low-end price segment

Total environmental impacts of all products produced in 2020 are listed in Table 81. These impacts refer to the total product lifetime, i.e. 2,5 years for this type of smartphones. Total energy demand for products covered by this Base Case is 28 PJ. Total greenhouse gas emissions are calculated 1,7 million tons (CO_2-equivalents).

Table 81 : Base Case 1 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	0	0	**0**
2	TecPlastics	kt			**3**		**0**	2	1	0	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**1**		**0**	1	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**6**		**0**	4	2	0	**0**
7	Misc.	kt			**11**		**0**	0	11	0	**0**
8	Extra	n.a.			12		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**23,8**		**0**	9	15	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	11,7	1,0	**12,7**	**6,1**	**9,1**	0,5	-1,8	0,0	**26,6**
12	of which, electricity (in primary PJ)	PJ	8,1	0,1	**8,2**	**0,0**	**9,1**	0,0	-1,2	0,0	**16,0**
13	Water (process)	mln. m3	15,5	0,1	**15,6**	**0,0**	**0,2**	0,0	-2,4	0,0	**13,4**
14	Water (cooling)	mln. m3	5,8	0,3	**6,0**	**0,0**	**0,5**	0,0	-0,9	0,0	**5,6**
15	Waste, non-haz./ landfill	kt	90,5	1,4	**91,8**	**5,8**	**5,5**	14,2	-8,0	0,0	**109,3**
16	Waste, hazardous/ incinerated	kt	8,4	0,0	**8,4**	**0,1**	**0,2**	0,0	-1,3	0,0	**7,5**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	0,9	0,1	**0,9**	**0,5**	**0,4**	0,0	-0,1	0,0	**1,7**
18	Acidification, emissions	kt SO2 eq.	12,3	0,4	**12,6**	**1,4**	**1,8**	0,1	-1,9	0,0	**14,0**
19	Volatile Organic Compounds (VOC)	kt	0,3	0,0	**0,3**	**0,0**	**0,2**	0,0	0,0	0,0	**0,5**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
21	Heavy Metals	ton Ni eq.	17,5	0,0	**17,6**	**0,3**	**0,3**	0,2	-2,7	0,0	**15,7**
22	PAHs	ton Ni eq.	0,1	0,0	**0,1**	**0,1**	**0,0**	0,0	0,0	0,0	**0,3**
23	Particulate Matter (PM, dust)	kt	0,4	0,1	**0,5**	**0,1**	**0,0**	0,0	-0,1	0,0	**0,6**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	70,5	0,0	**70,5**	**0,0**	**0,7**	0,3	-10,9	0,0	**60,6**
25	Eutrophication	kt PO4	0,6	0,0	**0,6**	**0,0**	**0,0**	0,1	-0,1	0,0	**0,7**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 82.

Table 82 : Base Case 1 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	0	0	**0**
2	TecPlastics	kt			**3**		**0**	2	1	0	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**1**		**0**	1	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**6**		**0**	4	2	0	**0**
7	Misc.	kt			**11**		**0**	0	11	0	**0**
8	Extra	n.a.			12		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**24**		**0**	9	15	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	11,7	1,0	**12,7**	**6,1**	**9,1**	0,5	-1,8	0,0	**27,9**
9	of which, electricity (in primary PJ)	PJ	8,1	0,1	**8,2**	**0,0**	**9,1**	0,0	-1,2	0,0	**17,3**
10	Water (process)	mln. m3	15,5	0,1	**15,6**	**0,0**	**0,2**	0,0	-2,4	0,0	**15,8**
11	Water (cooling)	mln. m3	5,8	0,3	**6,0**	**0,0**	**0,5**	0,0	-0,9	0,0	**6,5**
12	Waste, non-haz./ landfill	kt	90,5	1,4	**91,8**	**5,8**	**5,5**	14,2	-8,0	0,0	**103,1**
13	Waste, hazardous/ incinerated	kt	8,4	0,0	**8,4**	**0,1**	**0,2**	0,0	-1,3	0,0	**8,8**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	0,9	0,1	**0,9**	**0,5**	**0,4**	0,0	-0,1	0,0	**1,8**
16	Acidification, emissions	kt SO2 eq.	12,3	0,4	**12,6**	**1,4**	**1,8**	0,1	-1,9	0,0	**15,8**
17	Volatile Organic Compounds (VOC)	kt	0,3	0,0	**0,3**	**0,0**	**0,2**	0,0	0,0	0,0	**0,5**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
19	Heavy Metals	ton Ni eq.	17,5	0,0	**17,6**	**0,3**	**0,3**	0,2	-2,7	0,0	**18,1**
	PAHs	ton Ni eq.	0,1	0,0	**0,1**	**0,1**	**0,0**	0,0	0,0	0,0	**0,3**
20	Particulate Matter (PM, dust)	kt	0,4	0,1	**0,5**	**0,1**	**0,0**	0,0	-0,1	0,0	**0,6**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	70,5	0,0	**70,5**	**0,0**	**0,7**	0,3	-10,9	0,0	**71,3**
22	Eutrophication	kt PO4	0,6	0,0	**0,6**	**0,0**	**0,0**	0,1	-0,1	0,0	**0,6**

6.2. Base Case 2: Smartphone, display 6", mid-range

Total environmental impacts of all products produced in 2020 are listed in Table 83. These impacts refer to the total product lifetime, i.e. 3 years for this type of smartphones. Total energy demand for products covered by this Base Case is 31,6 PJ. Total greenhouse gas emissions are calculated 2,0 million tons (CO_2-equivalents).

Table 83 : Base Case 2 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	0	0	**0**
2	TecPlastics	kt			**2**		**0**	1	1	0	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**6**		**0**	2	4	0	**0**
5	Coating	t			1		0	0	0	0	0
6	Electronics	kt			**5**		**0**	4	2	0	**0**
7	Misc.	kt			**12**		**0**	0	12	0	**0**
8	Extra	n.a.			13		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**26,9**		**0**	8	19	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	15,7	0,9	**16,6**	**5,1**	**11,8**	0,7	-2,6	0,0	**31,6**
12	of which, electricity (in primary PJ)	PJ	10,4	0,1	**10,6**	**0,0**	**11,7**	0,0	-1,6	0,0	**20,7**
13	Water (process)	mln. m3	16,8	0,1	**16,9**	**0,0**	**0,2**	0,0	-2,6	0,0	**14,4**
14	Water (cooling)	mln. m3	8,2	0,3	**8,4**	**0,0**	**0,6**	0,0	-1,2	0,0	**7,8**
15	Waste, non-haz./ landfill	kt	128,7	1,7	**130,4**	**4,8**	**7,3**	20,1	-11,7	0,0	**150,9**
16	Waste, hazardous/ incinerated	kt	12,4	0,0	**12,4**	**0,1**	**0,3**	0,0	-1,9	0,0	**10,9**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	1,2	0,1	**1,2**	**0,4**	**0,5**	0,0	-0,2	0,0	**2,0**
18	Acidification, emissions	kt SO2 eq.	17,9	0,3	**18,2**	**1,1**	**2,4**	0,1	-2,8	0,0	**19,0**
19	Volatile Organic Compounds (VOC)	kt	0,4	0,0	**0,4**	**0,0**	**0,3**	0,0	-0,1	0,0	**0,6**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
21	Heavy Metals	ton Ni eq.	25,6	0,1	**25,7**	**0,2**	**0,4**	0,4	-4,0	0,0	**22,7**
22	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,6**
23	Particulate Matter (PM, dust)	kt	0,6	0,1	**0,7**	**0,1**	**0,1**	0,0	-0,1	0,0	**0,7**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	75,9	0,0	**75,9**	**0,0**	**0,8**	0,3	-11,8	0,0	**65,2**
25	Eutrophication	kt PO4	0,8	0,0	**0,8**	**0,0**	**0,0**	0,2	-0,1	0,0	**0,8**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 84.

Table 84 : Base Case 2 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	0	0	**0**
2	TecPlastics	kt			**2**		**0**	1	1	0	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**6**		**0**	2	4	0	**0**
5	Coating	t			1		0	0	0	0	0
6	Electronics	kt			**5**		**0**	4	2	0	**0**
7	Misc.	kt			**12**		**0**	0	12	0	**0**
8	Extra	n.a.			13		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**27**		**0**	8	19	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	15,7	0,9	**16,6**	**5,1**	**11,8**	0,7	-2,6	0,0	**33,5**
9	of which, electricity (in primary PJ)	PJ	10,4	0,1	**10,6**	**0,0**	**11,7**	0,0	-1,6	0,0	**22,3**
10	Water (process)	mln. m3	16,8	0,1	**16,9**	**0,0**	**0,2**	0,0	-2,6	0,0	**17,0**
11	Water (cooling)	mln. m3	8,2	0,3	**8,4**	**0,0**	**0,6**	0,0	-1,2	0,0	**9,0**
12	Waste, non-haz./ landfill	kt	128,7	1,7	**130,4**	**4,8**	**7,3**	20,1	-11,7	0,0	**142,5**
13	Waste, hazardous/ incinerated	kt	12,4	0,0	**12,4**	**0,1**	**0,3**	0,0	-1,9	0,0	**12,9**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	1,2	0,1	**1,2**	**0,4**	**0,5**	0,0	-0,2	0,0	**2,1**
16	Acidification, emissions	kt SO2 eq.	17,9	0,3	**18,2**	**1,1**	**2,4**	0,1	-2,8	0,0	**21,7**
17	Volatile Organic Compounds (VOC)	kt	0,4	0,0	**0,4**	**0,0**	**0,3**	0,0	-0,1	0,0	**0,6**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,2**
19	Heavy Metals	ton Ni eq.	25,6	0,1	**25,7**	**0,2**	**0,4**	0,4	-4,0	0,0	**26,3**
	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,7**
20	Particulate Matter (PM, dust)	kt	0,6	0,1	**0,7**	**0,1**	**0,1**	0,0	-0,1	0,0	**0,8**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	75,9	0,0	**75,9**	**0,0**	**0,8**	0,3	-11,8	0,0	**76,7**
22	Eutrophication	kt PO4	0,8	0,0	**0,8**	**0,0**	**0,0**	0,2	-0,1	0,0	**0,8**

6.3. Base Case 3: Smartphone, display 6,5", high-end

Total environmental impacts of all products produced in 2020 are listed in Table 85. These impacts refer to the total product lifetime, i.e. 3,5 years for this type of smartphones. Total energy demand for products covered by this Base Case is 38,8 PJ. Total greenhouse gas emissions are calculated 2,4 million tons (CO_2-equivalents).

Table 85 : Base Case 3 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	0	0	0	**0**
2	TecPlastics	kt			**2**		**0**	1	1	0	**0**
3	Ferro	kt			**1**		**0**	0	0	0	**0**
4	Non-ferro	kt			**6**		**0**	2	4	0	**0**
5	Coating	t			1		0	1	0	0	0
6	Electronics	kt			**6**		**0**	4	2	0	**0**
7	Misc.	kt			**12**		**0**	0	12	0	**0**
8	Extra	n.a.			13		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**26,4**		**0**	8	19	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	20,9	0,9	**21,8**	**4,4**	**15,1**	1,0	-3,4	0,0	**38,8**
12	of which, electricity (in primary PJ)	PJ	14,5	0,1	**14,6**	**0,0**	**15,0**	0,0	-2,2	0,0	**27,4**
13	Water (process)	mln. m3	19,6	0,1	**19,7**	**0,0**	**0,2**	0,0	-3,0	0,0	**16,8**
14	Water (cooling)	mln. m3	12,1	0,3	**12,3**	**0,0**	**0,8**	0,0	-1,9	0,0	**11,3**
15	Waste, non-haz./ landfill	kt	173,7	1,7	**175,4**	**4,1**	**9,4**	27,2	-15,7	0,0	**200,5**
16	Waste, hazardous/ incinerated	kt	18,6	0,0	**18,6**	**0,1**	**0,4**	0,0	-2,9	0,0	**16,3**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	1,6	0,1	**1,7**	**0,3**	**0,7**	0,0	-0,3	0,0	**2,4**
18	Acidification, emissions	kt SO2 eq.	26,2	0,3	**26,5**	**1,0**	**3,1**	0,2	-4,1	0,0	**26,6**
19	Volatile Organic Compounds (VOC)	kt	0,5	0,0	**0,5**	**0,0**	**0,3**	0,0	-0,1	0,0	**0,8**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
21	Heavy Metals	ton Ni eq.	38,0	0,1	**38,1**	**0,2**	**0,5**	0,5	-5,9	0,0	**33,4**
22	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,6**
23	Particulate Matter (PM, dust)	kt	0,8	0,1	**0,8**	**0,1**	**0,1**	0,0	-0,1	0,0	**0,9**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	97,6	0,0	**97,6**	**0,0**	**1,0**	0,4	-15,2	0,0	**83,9**
25	Eutrophication	kt PO4	1,0	0,0	**1,0**	**0,0**	**0,0**	0,2	-0,2	0,0	**1,1**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 86.

Table 86 : Base Case 3 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> Resources Use and Emissions		PRODUCTION Material	Manuf.	Total	DISTRI-BUTION	USE	END-OF-LIFE* Disposal	Recycl.	Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	0	0	0	**0**
2	TecPlastics	kt			**2**		**0**	1	1	0	**0**
3	Ferro	kt			**1**		**0**	0	0	0	**0**
4	Non-ferro	kt			**6**		**0**	2	4	0	**0**
5	Coating	t			1		0	1	0	0	0
6	Electronics	kt			**6**		**0**	4	2	0	**0**
7	Misc.	kt			**12**		**0**	0	12	0	**0**
8	Extra	n.a.			13		0	9	4	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**26**		**0**	8	19	0	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	20,9	0,9	**21,8**	**4,4**	**15,1**	1,0	-3,4	0,0	**41,3**
9	of which, electricity (in primary PJ)	PJ	14,5	0,1	**14,6**	**0,0**	**15,0**	0,0	-2,2	0,0	**29,6**
10	Water (process)	mln. m3	19,6	0,1	**19,7**	**0,0**	**0,2**	0,0	-3,0	0,0	**19,9**
11	Water (cooling)	mln. m3	12,1	0,3	**12,3**	**0,0**	**0,8**	0,0	-1,9	0,0	**13,1**
12	Waste, non-haz./ landfill	kt	173,7	1,7	**175,4**	**4,1**	**9,4**	27,2	-15,7	0,0	**188,9**
13	Waste, hazardous/ incinerated	kt	18,6	0,0	**18,6**	**0,1**	**0,4**	0,0	-2,9	0,0	**19,1**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	1,6	0,1	**1,7**	**0,3**	**0,7**	0,0	-0,3	0,0	**2,7**
16	Acidification, emissions	kt SO2 eq.	26,2	0,3	**26,5**	**1,0**	**3,1**	0,2	-4,1	0,0	**30,5**
17	Volatile Organic Compounds (VOC)	kt	0,5	0,0	**0,5**	**0,0**	**0,3**	0,0	-0,1	0,0	**0,8**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
19	Heavy Metals	ton Ni eq.	38,0	0,1	**38,1**	**0,2**	**0,5**	0,5	-5,9	0,0	**38,8**
	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,7**
20	Particulate Matter (PM, dust)	kt	0,8	0,1	**0,8**	**0,1**	**0,1**	0,0	-0,1	0,0	**1,0**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	97,6	0,0	**97,6**	**0,0**	**1,0**	0,4	-15,2	0,0	**98,7**
22	Eutrophication	kt PO4	1,0	0,0	**1,0**	**0,0**	**0,0**	0,2	-0,2	0,0	**1,0**

6.4. Base Case 4: Feature Phone

Total environmental impacts of all products produced in 2020 are listed in Table 87. These impacts refer to the total product lifetime, i.e. 3 years for feature phones. Total energy demand for products covered by this Base Case is 5,0 PJ. Total greenhouse gas emissions are calculated 0,3 million tons (CO_2-equivalents).

Table 87 : Base Case 4 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**0**		**0**	0	0	0	**0**
2	TecPlastics	kt			**1**		**0**	1	0	0	**0**
3	Ferro	kt			**0**		**0**	0	0	0	**0**
4	Non-ferro	kt			**0**		**0**	0	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**1**		**0**	1	1	-1	**0**
7	Misc.	kt			**4**		**0**	0	7	-2	**0**
8	Extra	n.a.			2		0	2	1	-1	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**7,1**		**0**	3	8	-4	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	1,3	0,2	**1,5**	**1,7**	**2,1**	0,1	-0,3	0,0	**5,0**
12	of which, electricity (in primary PJ)	PJ	0,6	0,0	**0,7**	**0,0**	**2,1**	0,0	-0,1	0,0	**2,6**
13	Water (process)	mln. m3	2,7	0,0	**2,7**	**0,0**	**0,0**	0,0	-0,6	0,0	**2,1**
14	Water (cooling)	mln. m3	0,5	0,1	**0,5**	**0,0**	**0,1**	0,0	-0,1	0,0	**0,5**
15	Waste, non-haz./ landfill	kt	13,1	0,3	**13,4**	**1,6**	**1,2**	3,1	-1,7	0,0	**17,5**
16	Waste, hazardous/ incinerated	kt	0,4	0,0	**0,4**	**0,0**	**0,0**	0,0	-0,1	0,0	**0,4**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	0,1	0,0	**0,1**	**0,1**	**0,1**	0,0	0,0	0,0	**0,3**
18	Acidification, emissions	kt SO2 eq.	0,8	0,1	**0,9**	**0,4**	**0,4**	0,0	-0,2	0,0	**1,5**
19	Volatile Organic Compounds (VOC)	kt	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,0**
21	Heavy Metals	ton Ni eq.	1,0	0,0	**1,0**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,9**
22	PAHs	ton Ni eq.	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
23	Particulate Matter (PM, dust)	kt	0,0	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	9,4	0,0	**9,4**	**0,0**	**0,1**	0,1	-2,2	0,0	**7,4**
25	Eutrophication	kt PO4	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 88.

Table 88 : Base Case 4 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**0**		**0**	0	0	0	**0**
2	TecPlastics	kt			**1**		**0**	1	0	0	**0**
3	Ferro	kt			**0**		**0**	0	0	0	**0**
4	Non-ferro	kt			**0**		**0**	0	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**1**		**0**	1	1	-1	**0**
7	Misc.	kt			**4**		**0**	0	7	-2	**0**
8	Extra	n.a.			2		0	2	1	-1	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**7**		**0**	3	8	-4	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	1,3	0,2	**1,5**	**1,7**	**2,6**	0,1	-0,3	0,0	**5,8**
9	of which, electricity (in primary PJ)	PJ	0,6	0,0	**0,7**	**0,0**	**2,6**	0,0	-0,1	0,0	**3,3**
10	Water (process)	mln. m3	2,7	0,0	**2,7**	**0,0**	**0,0**	0,0	-0,6	0,0	**2,7**
11	Water (cooling)	mln. m3	0,5	0,1	**0,5**	**0,0**	**0,1**	0,0	-0,1	0,0	**0,7**
12	Waste, non-haz./ landfill	kt	13,1	0,3	**13,4**	**1,6**	**1,5**	3,1	-1,7	0,0	**16,5**
13	Waste, hazardous/ incinerated	kt	0,4	0,0	**0,4**	**0,0**	**0,0**	0,0	-0,1	0,0	**0,5**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	0,1	0,0	**0,1**	**0,1**	**0,1**	0,0	0,0	0,0	**0,3**
16	Acidification, emissions	kt SO2 eq.	0,8	0,1	**0,9**	**0,4**	**0,5**	0,0	-0,2	0,0	**1,8**
17	Volatile Organic Compounds (VOC)	kt	0,0	0,0	**0,0**	**0,0**	**0,1**	0,0	0,0	0,0	**0,1**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,0**
19	Heavy Metals	ton Ni eq.	1,0	0,0	**1,0**	**0,1**	**0,0**	0,0	-0,2	0,0	**1,1**
	PAHs	ton Ni eq.	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
20	Particulate Matter (PM, dust)	kt	0,0	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	9,4	0,0	**9,4**	**0,0**	**0,1**	0,1	-2,2	0,0	**9,6**
22	Eutrophication	kt PO4	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**

6.5. Base Case 5: DECT cordless landline phone, with charging cradle / base station

Total environmental impacts of all products produced in 2020 are listed in Table 89. These impacts refer to the total product lifetime, i.e. 5 years for cordless phones. Total energy demand for products covered by this Base Case is 6,1 PJ. Total greenhouse gas emissions are calculated 0,3 million tons (CO_2-equivalents).

Table 89 : Base Case 5 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**2**		**0**	1	1	-1	**0**
2	TecPlastics	kt			**1**		**0**	0	0	0	**0**
3	Ferro	kt			**0**		**0**	0	0	0	**0**
4	Non-ferro	kt			**0**		**0**	0	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**1**		**0**	1	1	0	**0**
7	Misc.	kt			**2**		**0**	0	2	0	**0**
8	Extra	n.a.			2		0	1	1	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**6,1**		**0**	3	5	-1	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	1,1	0,3	**1,4**	**1,6**	**3,3**	0,0	-0,3	0,0	**6,1**
12	of which, electricity (in primary PJ)	PJ	0,5	0,1	**0,5**	**0,0**	**3,3**	0,0	-0,1	0,0	**3,7**
13	Water (process)	mln. m3	2,1	0,0	**2,2**	**0,0**	**0,0**	0,0	-0,5	0,0	**1,7**
14	Water (cooling)	mln. m3	0,8	0,1	**0,8**	**0,0**	**0,2**	0,0	-0,2	0,0	**0,8**
15	Waste, non-haz./ landfill	kt	4,7	0,5	**5,2**	**1,5**	**1,7**	0,6	-1,2	0,0	**7,9**
16	Waste, hazardous/ incinerated	kt	0,3	0,0	**0,3**	**0,0**	**0,1**	0,0	-0,1	0,0	**0,3**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	0,1	0,0	**0,1**	**0,1**	**0,1**	0,0	0,0	0,0	**0,3**
18	Acidification, emissions	kt SO2 eq.	0,9	0,1	**1,0**	**0,4**	**0,6**	0,0	-0,2	0,0	**1,7**
19	Volatile Organic Compounds (VOC)	kt	0,0	0,0	**0,0**	**0,0**	**0,1**	0,0	0,0	0,0	**0,1**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,0**
21	Heavy Metals	ton Ni eq.	0,7	0,0	**0,7**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,7**
22	PAHs	ton Ni eq.	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
23	Particulate Matter (PM, dust)	kt	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	5,8	0,0	**5,8**	**0,0**	**0,1**	0,0	-1,4	0,0	**4,5**
25	Eutrophication	kt PO4	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 90.

Table 90 : Base Case 5 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**2**		**0**	1	1	-1	**0**
2	TecPlastics	kt			**1**		**0**	0	0	0	**0**
3	Ferro	kt			**0**		**0**	0	0	0	**0**
4	Non-ferro	kt			**0**		**0**	0	0	0	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**1**		**0**	1	1	0	**0**
7	Misc.	kt			**2**		**0**	0	2	0	**0**
8	Extra	n.a.			2		0	1	1	0	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**6**		**0**	3	5	-1	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	1,1	0,3	**1,4**	**1,6**	**3,5**	0,0	-0,3	0,0	**6,5**
9	of which, electricity (in primary PJ)	PJ	0,5	0,1	**0,5**	**0,0**	**3,5**	0,0	-0,1	0,0	**4,0**
10	Water (process)	mln. m3	2,1	0,0	**2,2**	**0,0**	**0,0**	0,0	-0,5	0,0	**2,2**
11	Water (cooling)	mln. m3	0,8	0,1	**0,8**	**0,0**	**0,2**	0,0	-0,2	0,0	**1,0**
12	Waste, non-haz./ landfill	kt	4,7	0,5	**5,2**	**1,5**	**1,8**	0,6	-1,2	0,0	**8,5**
13	Waste, hazardous/ incinerated	kt	0,3	0,0	**0,3**	**0,0**	**0,1**	0,0	-0,1	0,0	**0,4**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	0,1	0,0	**0,1**	**0,1**	**0,1**	0,0	0,0	0,0	**0,4**
16	Acidification, emissions	kt SO2 eq.	0,9	0,1	**1,0**	**0,4**	**0,7**	0,0	-0,2	0,0	**2,0**
17	Volatile Organic Compounds (VOC)	kt	0,0	0,0	**0,0**	**0,0**	**0,1**	0,0	0,0	0,0	**0,1**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,0	0,0	**0,0**	**0,0**	**0,0**	0,0	0,0	0,0	**0,0**
19	Heavy Metals	ton Ni eq.	0,7	0,0	**0,7**	**0,1**	**0,0**	0,0	-0,2	0,0	**0,8**
	PAHs	ton Ni eq.	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
20	Particulate Matter (PM, dust)	kt	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	5,8	0,0	**5,8**	**0,0**	**0,1**	0,0	-1,4	0,0	**5,9**
22	Eutrophication	kt PO4	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**

6.6. Base Case 6: Tablet (no attached keyboard)

Total environmental impacts of all products produced in 2020 are listed in Table 91. These impacts refer to the total product lifetime, i.e. 5 years for tablets. Total energy demand for products covered by this Base Case is 22,1 PJ. Total greenhouse gas emissions are calculated 1,3 million tons (CO_2-equivalents).

Table 91 : Base Case 6 – EU total impact of new products produced in 2020 over their lifetime

Nr	EU Impact of New Models sold reference year over their lifetime:	Date	Author
0	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases -->		PRODUCTION			DISTRI-	USE	END-OF-LIFE*			TOTAL
	Resources Use and Emissions		Material	Manuf.	Total	BUTION		Disposal	Recycl.	Stock	
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	1	-1	**0**
2	TecPlastics	kt			**2**		**0**	2	1	-1	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**6**		**0**	4	7	-5	**0**
5	Coating	t			0		0	0	0	0	0
6	Electronics	kt			**6**		**0**	7	3	-4	**0**
7	Misc.	kt			**16**		**0**	0	29	-12	**0**
8	Extra	n.a.			18		0	22	9	-13	0
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerant	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**31,7**		**0**	15	41	-24	**0**
									see note!		
	Other Resources & Waste							debet	credit		
11	Total Energy (GER)	PJ	11,4	1,0	**12,4**	**2,8**	**9,5**	0,9	-3,5	0,0	**22,1**
12	of which, electricity (in primary PJ)	PJ	7,2	0,2	**7,3**	**0,0**	**9,5**	0,0	-1,9	0,0	**14,9**
13	Water (process)	mln. m3	13,2	0,1	**13,2**	**0,0**	**0,1**	0,0	-3,6	0,0	**9,8**
14	Water (cooling)	mln. m3	4,5	0,3	**4,8**	**0,0**	**0,5**	0,0	-1,2	0,0	**4,1**
15	Waste, non-haz./ landfill	kt	70,8	1,8	**72,6**	**2,6**	**5,6**	19,0	-12,0	0,0	**87,8**
16	Waste, hazardous/ incinerated	kt	6,9	0,0	**6,9**	**0,1**	**0,2**	0,0	-1,9	0,0	**5,3**
	Emissions (Air)										
17	Greenhouse Gases in GWP100	mt CO2 eq.	0,8	0,1	**0,9**	**0,2**	**0,4**	0,0	-0,2	0,0	**1,3**
18	Acidification, emissions	kt SO2 eq.	10,2	0,3	**10,5**	**0,6**	**1,9**	0,1	-2,8	0,0	**10,3**
19	Volatile Organic Compounds (VOC)	kt	0,3	0,0	**0,3**	**0,0**	**0,2**	0,0	-0,1	0,0	**0,4**
20	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
21	Heavy Metals	ton Ni eq.	14,3	0,1	**14,4**	**0,1**	**0,2**	0,3	-3,9	0,0	**11,3**
22	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,3	0,0	**0,4**
23	Particulate Matter (PM, dust)	kt	0,4	0,1	**0,5**	**0,1**	**0,0**	0,0	-0,1	0,0	**0,5**
	Emissions (Water)										
24	Heavy Metals	ton Hg/20	55,6	0,0	**55,6**	**0,0**	**0,6**	0,4	-15,0	0,0	**41,5**
25	Eutrophication	kt PO4	0,6	0,0	**0,6**	**0,0**	**0,0**	0,2	-0,2	0,0	**0,6**

For the year 2020 the production, use and end-of-life of all products covered by this Base Case results in the total impacts listed in Table 92.

Table 92 : Base Case 6 – EU total impact of stock of products in 2020 (produced, used, discarded)

Nr	EU Impact of Products in reference year (produced, in use, discarded)***	Date	Author
	Products	2020	Fraunhofer IZM

Nr	Life Cycle phases --> Resources Use and Emissions	unit	PRODUCTION Material	PRODUCTION Manuf.	PRODUCTION Total	DISTRI-BUTION	USE	END-OF-LIFE* Disposal	END-OF-LIFE* Recycl.	END-OF-LIFE* Stock	TOTAL
	Materials	**unit**									
1	Bulk Plastics	kt			**1**		**0**	1	1	-1	**0**
2	TecPlastics	kt			**2**		**0**	2	1	-1	**0**
3	Ferro	kt			**1**		**0**	1	0	0	**0**
4	Non-ferro	kt			**6**		**0**	4	7	-5	**0**
5	Coating	kt			**0**		**0**	0	0	0	**0**
6	Electronics	kt			**6**		**0**	7	3	-4	**0**
7	Misc.	kt			**16**		**0**	0	29	-12	**0**
8	Extra	kt			**18**		**0**	22	9	-13	**0**
9	Auxiliaries	kt			**0**		**0**	0	0	0	**0**
10	Refrigerants	kt			**0**		**0**	0	0	0	**0**
	Total weight	kt			**32**		**0**	15	41	-24	**0**
									see note!		
	Other Resources & Waste							debet	credit		
8	Total Energy (GER)	PJ	11,4	1,0	**12,4**	**2,8**	**12,0**	0,9	-3,5	0,0	**27,2**
9	of which, electricity (in primary PJ)	PJ	7,2	0,2	**7,3**	**0,0**	**12,0**	0,0	-1,9	0,0	**19,3**
10	Water (process)	mln. m3	13,2	0,1	**13,2**	**0,0**	**0,2**	0,0	-3,6	0,0	**13,4**
11	Water (cooling)	mln. m3	4,5	0,3	**4,8**	**0,0**	**0,6**	0,0	-1,2	0,0	**5,3**
12	Waste, non-haz./ landfill	kt	70,8	1,8	**72,6**	**2,6**	**7,0**	19,0	-12,0	0,0	**82,2**
13	Waste, hazardous/ incinerated	kt	6,9	0,0	**6,9**	**0,1**	**0,3**	0,0	-1,9	0,0	**7,2**
	Emissions (Air)										
14	Greenhouse Gases in GWP100	Mt CO2 eq.	0,8	0,1	**0,9**	**0,2**	**0,5**	0,0	-0,2	0,0	**1,6**
16	Acidification, emissions	kt SO2 eq.	10,2	0,3	**10,5**	**0,6**	**2,4**	0,1	-2,8	0,0	**13,5**
17	Volatile Organic Compounds (VOC)	kt	0,3	0,0	**0,3**	**0,0**	**0,3**	0,0	-0,1	0,0	**0,6**
18	Persistent Organic Pollutants (POP)	g i-Teq	0,1	0,0	**0,1**	**0,0**	**0,0**	0,0	0,0	0,0	**0,1**
19	Heavy Metals	ton Ni eq.	14,3	0,1	**14,4**	**0,1**	**0,3**	0,3	-3,9	0,0	**14,8**
	PAHs	ton Ni eq.	0,6	0,0	**0,6**	**0,1**	**0,0**	0,0	-0,3	0,0	**0,7**
20	Particulate Matter (PM, dust)	kt	0,4	0,1	**0,5**	**0,1**	**0,1**	0,0	-0,1	0,0	**0,6**
	Emissions (Water)										
21	Heavy Metals	ton Hg/20	55,6	0,0	**55,6**	**0,0**	**0,8**	0,4	-15,0	0,0	**56,3**
22	Eutrophication	kt PO4	0,6	0,0	**0,6**	**0,0**	**0,0**	0,2	-0,2	0,0	**0,6**

6.7. Comparison of Base Cases results and totals

The totals annual impact in the Base Case tables above allows comparison with EU28 totals – as of 2011 - and with other products, as regards resource use and emissions. These emissions, with electricity converted to a more familiar unit of TWh [1 TWh= 0.0105 PJ] are given in the following summary Table 93.

Data shows that the Base Case segment of high-end smartphones dominates most of the environmental indicators. Base Cases 4 (feature phone) and Base Case 5 (cordless phone) do not contribute much to the overall impacts of this product group across all indicators.

The contribution of this product group to the total EU (then EU28!) impacts as of 2011 is 0,19% in terms of Total Energy. However, most of this is embedded energy imported to the EU. The greenhouse gas emissions of the products in stock correspond to 0,18% of the EU totals. Heavy metal emissions to air and water correspond to 1,7% and 2,56% of EU totals, being the highest relative contribution to any of the environmental indicators.

Table 93 : Base Cases 1-6 – EU total impact of stock of products in 2020 (produced, used, discarded) compared to EU28 totals as of 2011

Summary Environmental Impacts EU-Stock										
Main life cycle indicators							value	unit	%	EU totals
	BC1	BC2	BC3	BC4	BC5	BC6	all BCs			
Materials										
Plastics	0,004	0,003	0,003	0,001	0,003	0,003	**0,016**	Mt	**0,034%**	48
Ferrous metals	0,001	0,001	0,001	0,000	0,000	0,001	**0,003**	Mt	**0,002%**	206
Non-ferrous metals	0,001	0,006	0,006	0,000	0,000	0,006	**0,020**	Mt	**0,102%**	20
Other resources & waste										
Total Energy (GER)	27,915	33,495	41,252	5,802	6,481	27,199	**142,145**	PJ	**0,188%**	75.697
of which, electricity	*1,919*	*2,476*	*3,288*	*0,367*	*0,445*	*2,142*	**10,638**	TWh	**0,380%**	2.800
Water (process)*	15,752	17,037	19,879	2,737	2,176	13,396	**70,977**	mln.m3	**0,029%**	247.000
Waste, non-haz./ landfill*	0,103	0,143	0,189	0,017	0,009	0,082	**0,542**	Mt	**0,018%**	2.947
Waste, hazardous/ incinerated*	0,009	0,013	0,019	0,001	0,000	0,007	**0,049**	kton	**0,055%**	89
Emissions (Air)										
Greenhouse Gases in GWP100	1,794	2,148	2,662	0,333	0,355	1,624	**8,915**	mt CO2eq.	**0,18%**	5.054
Acidifying agents (AP)	15,836	21,745	30,547	1,774	1,988	13,520	**85,410**	kt SO2eq.	**0,38%**	22.432
Volatile Org. Compounds (VOC)	0,505	0,640	0,828	0,095	0,091	0,570	**2,730**	kt	**0,03%**	8.951
Persistent Org. Pollutants (POP)	0,093	0,157	0,143	0,022	0,025	0,141	**0,581**	g i-Teq.	**0,03%**	2.212
Heavy Metals (HM)	18,128	26,297	38,799	1,148	0,845	14,834	**100,051**	ton Ni eq.	**1,69%**	5.903
PAHs	0,296	0,729	0,713	0,080	0,130	0,719	**2,667**	ton Ni eq.	**0,19%**	1.369
Particulate Matter (PM, dust)	0,600	0,774	0,963	0,088	0,131	0,632	**3,188**	kt	**0,09%**	3.522
Emissions (Water)										
Heavy Metals (HM)	71,278	76,699	98,682	9,579	5,894	56,338	**318,470**	ton Hg/20	**2,48%**	12.853
Eutrophication (EP)	0,641	0,783	1,000	0,087	0,072	0,582	**3,166**	kt PO4	**0,35%**	900

Although total impacts of Base Cases 4 (feature phones) and Base Case 5 (cordless phones) are significantly lower than for the other Base Cases they still represent sales of 15 million and 13,8 million units respectively, which is well above the indicative value set for considering eco-design measures: "the product shall represent a significant volume of sales and trade, indicatively more than 200 000 units a year within the Community according to the most recently available figures", according to Art. 5 of Directive 2009/125/EC.

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